SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, MARCH 13, 1903.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*ON THE FOUNDATIONS OF MATHEMATICS.**

THE American Mathematical Society gives its retiring president the privilege of speaking on whatever he may have at heart. Accordingly, this afternoon I propose to consider with you some matters of importance—indeed, perhaps of fundamental importance—in the development of mathematics in this country; and it will duly appear in what non-technical sense I am speaking 'On the Foundations of Mathematics.'

A VIEW.

Abstract Mathematics.—The notion within a given domain of defining the objects of consideration rather by a body of properties than by particular expressions or intuitions is as old as mathematics itself. And yet the central importance of the notion appeared only during the last century—in a host of researches on special theories and on the foundations of geometry and analysis. Thus has arisen the general point of view of what may be called *abstract mathematics.* One comes in touch with the literature very conveniently by the mediation of Peano's *Revue des Mathématiques.* The Italian school of Peano and the *Formulaire Mathématique,* published in connection with the *Revue,*

* Presidential address delivered before The American Mathematical Society at its ninth annual meeting, December 29, 1902.

are devoted to the codification in Peano's symbolic language of the principal mathematical theories, and to researches on abstract mathematics. General interest in abstract mathematics was aroused by Hilbert's Gauss-Weber Festschrift of 1899: 'Ueber die Grundlagen der Geometrie,' a memoir rich in results and suggestive in methods; I refer to the reviews by Sommer,* Poincaré,† Halsted,‡ Hedrick§ and Veblen.‖

We have as a basal science logic, and as depending upon it the special deductive sciences which involve undefined symbols and whose propositions are not all capable of proof. The symbols denote either classes of elements or relations amongst elements. In any such science one may choose in various ways the system of undefined symbols and the system of undemonstrated or primitive propositions, or postulates. Every proposition follows from the postulates by a finite number of logical steps. A careful statement of the fundamental generalities is given by Padoa in a paper¶ before the Paris Congress of Philosophy, 1900.

Having in mind a definite system of undefined symbols and a definite system of postulates, we have first of all the notion of the compatibility of these postulates; that is, that it is impossible to prove by a finite number of logical steps the simultaneous validity of a statement and its contradictory statement; in the next place, the question of the independence of the postulates or the irreducibility of the system of postulates; that is, that no postulate is provable from the remaining postulates. Padoa introduces the notion of the irreducibility of the system of undefined symbols. A system of undefined symbols is said to be reducible if for one of the symbols, X, it is possible to establish, as a logical consequence of the assumption of the validity of the postulates, a nominal or symbolic definition of the form $X = A$, where in the expression A there enter only the undefined symbols distinct from X. For the purpose of practical application, it seems to be desirable to modify the definition so as to call the system of undefined symbols reducible if there is a nominal definition $X = A$ of one of them X in terms of the others such that in any interpretation of the science the postulates retain their validity when instead of the initial interpretation of the symbol X there is placed the interpretation A of that symbol. If the system of symbols is reducible in the sense of the original definition it is in the sense of the new definition, but not necessarily conversely, as appears for instance from the following example, occurring in the foundations of geometry.

Hilbert uses the following undefined symbols: 'point,' 'line,' 'plane,' 'incidence' of point and line, 'incidence' of point and plane, 'between,' and 'congruent.' Now it is possible to give for the symbol 'plane' a symbolic definition in terms of the other undefined symbols—for instance, a plane is a certain class of points (as Peano showed in 1892), or again, a plane is a certain class of lines; while the notion 'incidence' of point and plane receives convenient definition. It is apparent from the fact that these definitions may be given in these two ways that Hilbert's system of undefined symbols is not in Padoa's sense irreducible, at least, in so far as the symbols 'plane,' 'incidence' of point and plane are

* *Bull. Amer. Math. Soc.* (2), vol. 6 (1900), p. 287.

† *Bull. Sciences Mathém.*, vol. 26 (1902), p. 249.

‡ *The Open Court*, September, 1902.

§ *Bull. Amer. Math. Soc.* (2), vol. 9 (1902), p. 158.

‖ *The Monist*, January, 1903.

¶ 'Essai d'une théorie algébrique des nombres entiers, précédé d'une Introduction logique à une théorie déductive quelconque,' *Bibliothèque du Congrès International de Philosophie*, vol. 3, p. 309.

concerned—while it is equally clear that these symbols are in the abstract geometry superfluous.

In his dissertation on euclidean geometry, Mr. Veblen, following the example of Pasch and Peano, takes as undefined symbols 'point' and 'between,' or 'point' and 'segment.' In terms of these two symbols alone he expresses a set of independent fundamental postulates of euclidean geometry, in the first place developing the projective geometry, and then as to congruence relating himself to the point of view of Klein in his 'Erlangen Programm,' whereby the group of movements of euclidean geometry enters as a certain subgroup of the group of collineations of projective geometry. Here arises an interesting question as to the sense in which the undefined symbol 'congruence' is superfluous in the euclidean geometry based upon the symbols 'point,' 'between.' One sees at once that a definition of 'congruence' involves parametric points in its expression, while on the other hand a definition of the system of all 'planes,' that is, of the general concept 'plane,' involves no such parametric elements. But, again, just as there exist distinct definitions of 'congruence,' owing to a variation of the parametric points, so there exist distinct definitions of the general concept 'plane,' as was indicated a moment ago. One has the feeling that the state of affairs must be as follows: In any interpretation of, say, Hilbert's symbols, wherein the postulates of Hilbert are valid, every valid statement which does not involve the symbol 'plane' in direct connection with the general logical symbol (=) of symbolic definition, remains valid when we modify it in accordance with either of the definitions of 'plane' previously referred to. On the other hand, this state of affairs does not hold for the symbol 'congruence.' The proof of the former statement would seem to involve fundamental logical niceties.

The compatibility and the independence of the postulates of a system of postulates of a special deductive science have been up to this time always made to depend upon the self-consistency of some other deductive science; for instance, geometry depends thus upon analysis, or analysis upon geometry. The fundamental and still unsolved problem in this direction is that of the direct proof of the compatibility of the postulates of arithmetic, or of the real number system of analysis. (To the society this morning Dr. Huntington exhibited two sets of independent postulates for this real number system.) This is the second of the twenty-three problems listed by Hilbert in his address before the Paris Mathematical Congress of 1900.

The Italian writers on abstract mathematics for the most part make use of Peano's symbolism. One may be tempted to feel that this symbolism is not an essential part of their work. It is only right to state, however, that the symbolism is not difficult to learn, and that there is testimony to the effect that the symbolism is actually of great value to the investigator in removing from attention the concrete connotations of the ordinary terms of general and mathematical language. But of course the essential difficulties are not to be obviated by the use of any symbolism, however delicate.

Indeed the question arises whether the abstract mathematicians in making precise the metes and bounds of logic and the special deductive sciences are not losing sight of the evolutionary character of all life-processes, whether in the individual or in the race. Certainly the logicians do not consider their science as something now fixed. All science, logic and mathematics included, is a function of the epoch—all science, in its ideals as well as in its achieve-

ments. Thus with Hilbert let a special deductive or mathematical science be based upon a finite number of symbols related by a finite number of compatible postulates, every proposition of the science being deducible by a finite number of logical steps from the postulates. The content of this conception is far from absolute. It involves what presuppositions as to general logic? What is a finite number? In what sense is a postulate—for example, that any two distinct points determine a line—a single postulate? What are the permissible logical steps of deduction? Would the usual syllogistic steps of formal logic suffice? Would they suffice even with the aid of the principle of mathematical induction, in which Poincaré finds* the essential synthetic element of mathematical argumentation the basis of that generality without which there would be no science? In what sense is mathematical induction a single logical step of deduction?

One has then the feeling that the carrying out in an absolute sense of the program of the abstract mathematicians will be found impossible. At the same time, one recognizes the importance attaching to the effort to do precisely this thing. The requirement of rigor tends toward essential simplicity of procedure, as Hilbert has insisted in his Paris address, and the remark applies to this question of mathematical logic and its abstract expression.

Pure and Applied Mathematics.—In the ultimate analysis for any epoch, we have general logic, the mathematical sciences,† that is, all special formally and abstractly deductive self-consistent sciences, and the natural sciences, which are inductive and informally deductive. While this classification may be satisfactory as an ideal one, it fails to recognize the fact that in mathematical research one by no means confines himself to processes which are mathematical according to this definition; and if this is true with respect to the research of professional mathematicians, how much more is it true with respect to the study, which should throughout be conducted in the spirit of research, on the part of students of mathematics in the elementary schools and colleges and universities. I refer to the articles* of Poincaré on the rôle of intuition and logic in mathematical research and education.

It is apparent that this ideal classification can be made by the devotee of science only when he has reached a considerable degree of scientific maturity, that perhaps it would fail to appeal to non-mathematical experts, and that it does not accord with the definitions given by practical working mathematicians. Indeed, the attitude of practical mathematicians toward this whole subject of abstract mathematics, and especially the symbolic form of abstract mathematics, is not unlike that of the practical physicist toward the whole subject of theoretic mathematics, and in turn not unlike that of the practical engineer toward the whole subject of theoretical physics and mathematics. Furthermore, every one understands that many of the most important advances of pure mathematics have arisen in connection with investigations originating in the domain of natural phenomena.

Practically then it would seem desirable

* 'Sur la nature du raisonnement mathématique,' *Revue de Métaphysique et de Morale*, vol. 2 (1894), pp. 371–384.

† Of which none is at present known to exist.

* 'La logique et l'intuition dans la science mathématique et dans l'enseignement,' *L'Enseignement Mathématique*, vol. 1 (1899), pp. 157–162. 'Du rôle de l'intuition et de la logique en mathématiques,' *Compte Rendu du Deuxième Congrès International des Mathématiciens*, Paris [1900], 1902, pp. 115–130. 'Sur les rapports de l'analyse pure et de la physique mathématique,' Conference, Zurich, 1897; *Acta Mathematica*, vol. 21, p. 238.

for the interests of science in general that there should be a strong body of men thoroughly possessed of the scientific method in both its inductive and its deductive forms. We are confronted with the questions: What is science? What is the scientific method? What are the relations between the mathematical and the natural scientific processes of thought? As to these questions, I refer to articles and addresses of Poincaré,* Boltzmann† and Burkhardt,‡ and to Mach's 'Science of Mechanics' and Pearson's 'Grammar of Science.'

Without elaboration of metaphysical or psychological details, it is sufficient to refer to the thought that the individual, as confronted with the world of phenomena in his effort to obtain control over this world, is gradually forced to appreciate a knowledge of the usual coexistences and sequences of phenomena, and that science arises as the body of formulas serving to epitomize or summarize conveniently these usual coexistences and sequences. These formulas are of the nature of more or less exact descriptions of phenomena; they are not of the nature of explanations. Of all the relations entering into the formulas of science, the fundamental mathematical notions of number and measure and form were among the earliest, and pure mathematics in its ordinary acceptation may be understood to be the systematic development of the properties of these notions, in accordance with conditions prescribed by physical phenomena. Arithmetic and geometry, closely united in mensuration and trigonometry, early reached a high degree of advancement. But after the development of the generalizing literal notations of algebra, and largely in response to the insistent demands of mechanics, astronomy and physics, the seventeenth century, binding together arithmetic and geometry infinitely more closely, created analytic geometry and the infinitesimal calculus, those mighty methods of research whose application to all branches of the theoretical and practical physical sciences so fundamentally characterizes the civilization of to-day.

The eighteenth century was devoted to the development of the powers of these new instruments in all directions. While this development continued during the nineteenth century, the dominant note of the nineteenth century was that of critical reorganization of the foundations of pure mathematics, so that, for instance, the majestic edifice of analysis was seen to rest upon the arithmetic of positive integers alone. This reorganization and the consequent course of development of pure mathematics were independent of the question of the application of mathematics to the sister sciences. There has thus arisen a chasm between pure mathematics and applied mathematics. There have not been lacking, however, influences making toward the bridging of this chasm; one thinks especially of the whole influence of Klein in Germany and of the École Polytechnique in France. As a basis of union of the pure mathematicians and the applied mathematicians, Klein has throughout emphasized the importance of a clear understanding of the relations between those two parts of mathematics which are conveniently called 'mathematics of precision' and 'mathematics of approximation,' and I refer especially to his latest work of this

* In addition to those already cited: 'On the Foundations of Geometry,' *The Monist*, vol. 9, October, 1898, pp. 1–43. 'Sur les principes de la mécanique,' *Bibliothèque du Congrès International de Philosophie*, vol. 3, pp. 457–494.

† 'Ueber die Methoden der theoretischen Physik,' *Dyck's Katalog mathematischer und mathematisch-physikalischer Modelle, Apparate und Instrumente*, pp. 89–98, Munich, 1892.

‡ 'Mathematisches und naturwissenschaftliches Denken,' *Jahresbericht der Deutschen Math.-Ver.*, vol. 11 (1902), pp. 49–57.

character, 'Anwendung der Differential und Integral-Rechnung auf Geometrie: Eine Revision der Principien' (Göttingen, summer semester, 1901, Teubner, 1902). This course of lectures is designed to present particular applications of the general notions of Klein, and, furthermore, it is in continuation of the discussion between Pringsheim and Klein and others, as to the desirable character of lectures on mathematics in the universities of Germany.

Elementary Mathematics.—This separation between pure mathematics and applied mathematics is grievous even in the domain of elementary mathematics. In witness, in the first place: The workers in physics, chemistry and engineering need more practical mathematics; and numerous text-books, in particular, on calculus, have recently been written from the point of view of these allied subjects. I refer to the works by Nernst and Schoenflies,* Lorentz† Perry‡ and Mellor,§ and to a book on the very elements of mathematics now in preparation by Oliver Lodge.

In the second place, I dare say you are all familiar with the surprisingly vigorous and effective agitation with respect to the teaching of elementary mathematics which is at present in progress in England, largely under the direction of John Perry, professor of mechanics and mathematics of the Royal College of Science, London, and chairman of the Board of Examiners of the Board of Education in the subjects of engineering, including practical plane and solid geometry, applied mechanics, practical mathematics, in addition to more technical subjects, and in this capacity in charge of the education of some hundred thousand apprentices in English night schools. The section on Education of the British Association had its first session at the Glasgow meeting, 1901, and the session was devoted to the consideration, in connection with the section on Mathematics and Physics, of the question of the pedagogy of mathematics, and Perry opened the discussion by a paper on 'The Teaching of Mathematics.' A strong committee under the chairmanship of Professor Forsyth, of Cambridge, was appointed 'to report upon improvements that might be effected in the teaching of mathematics, in the first instance, in the teaching of elementary mathematics, and upon such means as they think likely to effect such improvements.' The paper of Perry, with the discussion of the subject at Glasgow, and additions including the report of the committee as presented to the British Association at its Belfast meeting, September, 1902, are collected in a small volume, 'Discussion on the Teaching of Mathematics,' edited by Professor Perry (Macmillan, second edition, 1902).*

One should consult the books of Perry, 'Practical Mathematics,'† 'Applied Mechanics,'‡ 'Calculus for Engineers'§ and 'England's Neglect of Science,'‖ and his

* Nernst und Schoenflies, 'Einführung in die mathematische Behandlung der Naturwissenschaften (Munich and Leipsic, 1895); the basis of Young and Linebarger's 'Elements of Differential and Integral Calculus,' New York, 1900.

† Lorentz, 'Lehrbuch der Differential- und Integralrechnung,' Leipsic, 1900.

‡ Perry, 'Calculus for Engineers' (second edition, London, E. Arnold, 1897); German translation by Fricke (Teubner, 1902). Cf. also the citations given later on.

§ Mellor, 'Higher Mathematics for Students of Chemistry and Physics, with special reference to Practical Work,' Longmans, Green & Co., 1902, pp. xxi + 543.

* Cf. also 'Report on the Teaching of Elementary Mathematics issued by the Mathematical Association,' G. Bell & Sons, London, 1902.

† Published for the Board of Education by Eyre and Spottiswoode, London, 1899.

‡ D. Van Nostrand Co., New York, 1898.

§ Second edition, London, E. Arnold, 1897.

‖ T. Fisher Unwin, London, 1900.

address* on 'The Education of Engineers' —and furthermore the files from 1899 on of the English journals, *Nature, School World, Journal of Education* and *Mathematical Gazette.*

One important purpose of the English agitation is to relieve the English secondary school teachers from the burden of a too precise examination system, imposed by the great examining bodies; in particular, to relieve them from the need of retaining Euclid as the sole authority in geometry, at any rate with respect to the sequence of propositions. Similar efforts made in England about thirty years ago were unsuccessful. Apparently the forces operating since that time have just now broken forth into successful activity; for the report of the British Association committee was distinctly favorable, in a conservative sense, to the idea of reform, and already noteworthy initial changes have been made in the regulations for the secondary examinations by the examination syndicates of the universities of Oxford, Cambridge and London.

The reader will find the literature of this English movement very interesting and suggestive. For instance, in a letter to *Nature* (vol. 65, p. 484, March 27, 1902) Perry mildly apologizes for having to do with the movement whose immediate results are likely to be merely slight reforms, instead of thoroughgoing reforms called for in his pronouncements and justified by his marked success during over twenty years as a teacher of practical mathematics. He asserts that the orthodox logical sequence in mathematics is not the only possible one; that, on the contrary, a more logical sequence than the orthodox one (because one more possible of comprehension by students) is based upon the notions underlying the infinitesimal calculus taken as axioms; for instance, that a map may be drawn to scale; the notions underlying the many uses of squared paper; that decimals may be dealt with as ordinary numbers. He asserts as essential that the boy should be *familiar* (by way of experiment, illustration, measurement and by every possible means) with the ideas to which he applies his logic; and moreover that he should be thoroughly *interested* in the subject studied; and he closes with this peroration:

> "'Great God! I'd rather be
> A pagan, suckled in a creed outworn.'

I would rather be utterly ignorant of all the wonderful literature and science of the last twenty-four centuries, even of the wonderful achievements of the last fifty years, than not to have the sense that our whole system of so-called education is as degrading to literature and philosophy as it is to English boys and men."

As a pure mathematician, I hold as the most important suggestion of the English movement the suggestion of Perry's, just cited, that by emphasizing steadily the practical sides of mathematics, that is, arithmetic computations, mechanical drawing and graphical methods generally, in continuous relation with problems of physics and chemistry and engineering, it would be possible to give very young students a great body of the essential notions of trigonometry, analytic geometry, and the calculus. This is accomplished, on the one hand, by the increase of attention and comprehension obtained by connecting the abstract mathematics with subjects which are naturally of interest to the boy, so that, for instance, all the results obtained by theoretic process are capable of check by laboratory process, and, on the other hand, by a diminution of emphasis on the sys-

* In opening the discussion of the sections on Engineering and on Education at the Belfast, 1902, meeting of the British Association; published in SCIENCE, November 14, 1902.

tematic and formal sides of the instruction in mathematics. Undoubtedly many mathematicians will feel that this decrease of emphasis will result in much, if not irreparable, injury to the interests of mathematics. But I am inclined to think that the mathematician with the catholic attitude of an adherent of science, in general (and at any rate with respect to the problems of the pedagogy of elementary mathematics there would seem to be no other rational attitude) will see that the boy will be learning to make practical use in his scientific investigations—to be sure, in a naïve and elementary way—of the finest mathematical tools which the centuries have forged; that under skilful guidance he will learn to be interested not merely in the achievements of the tools, but in the theory of the tools themselves, and that thus he will ultimately have a feeling towards his mathematics extremely different from that which is now met with only too frequently—a feeling that mathematics is indeed itself a fundamental reality of the domain of thought, and not merely a matter of symbols and arbitrary rules and conventions.

The American Mathematical Society.—The American Mathematical Society has, naturally, interested itself chiefly in promoting the interests of research in mathematics. It has, however, recognized that those interests are closely bound up with the interests of education in mathematics. I refer in particular to the valuable work done by the committee appointed, with the authorization of the Council, by the Chicago section of the society, to represent mathematics in connection with Dr. Nightingale's committee of 1899 of the National Educational Association in the formulation of standard curricula for high schools and academies, and to the fact that two committees are now at work, one appointed in December, 1901, by the Chicago Section, to formulate the desirable conditions for the granting, by institutions of the Mississippi valley, of the degree of Master of Arts for work in mathematics, and the other appointed by the society at its last summer meeting to cooperate with similar committees of the National Educational Association and of the Society for the Promotion of Engineering Education, in formulating standard definitions of requirements in mathematical subjects for admission to colleges and technological schools; and furthermore I refer to the fact that (although not formally) the society has made a valuable contribution to the interests of secondary education in that the College Entrance Examination Board has as its secretary the principal founder of the society. I have accordingly felt at liberty to bring to the attention of the society these matters of the pedagogy of elementary mathematics, and I do so with the firm conviction that it would be possible for the society, by giving still more attention to these matters, to further most effectively the highest interests of mathematics in this country.

A VISION.

An Invitation.—The pure mathematicians are invited to determine how mathematics is regarded by the world at large, including their colleagues of other science departments and the students of elementary mathematics, and to ask themselves whether by modification of method and attitude they may not win for it the very high position in general esteem and appreciative interest which it assuredly deserves.

This general invitation and the preceding summary view invoke this vision of the future of elementary mathematics in this country.

The Pedagogy of Elementary Mathematics.—We survey the pedagogy of elementary mathematics in the primary schools, in the secondary schools and in the junior colleges (the lower collegiate years). It is, however, understood that

there is a movement for the enlargement of the strong secondary schools, by the addition of the two years of junior college work and by the absorption of the last two or three grades of the primary schools, into institutions more of the type of the German gymnasia and the French lycée;* in favor of this movement there are strong arguments, and among them this, that in such institutions, especially if closely related to strong colleges or universities, the mathematical reforms may the more easily be carried out.

The fundamental problem is that of *the unification of pure and applied mathematics.* If we recognize the branching implied by the very terms 'pure,' 'applied,' we have to do with a special case of *the correlation of different subjects* of the curriculum, a central problem in the domain of pedagogy from the time of Herbart on. In this case, however, the fundamental solution is to be found rather by way of indirection—by arranging the curriculum so that throughout the domain of elementary mathematics the branching be not recognized.

The Primary Schools.—Would it not be possible for the children in the grades to be trained in power of observation and experiment and reflection and deduction so that always their mathematics should be directly connected with matters of thoroughly concrete character? The response is immediate that this is being done to-day in the kindergartens and in the better elementary schools. I understand that serious difficulties arise with children of from nine to twelve years of age, who are no longer contented with the simple, concrete methods of earlier years and who, nevertheless, are unable to appreciate the more abstract methods of the later years. These difficulties, some say, are to be met by allowing the mathematics to enter only implicitly in connection with the other subjects of the curriculum. But rather the material and methods of the mathematics should be enriched and vitalized. In particular, the grade teachers must make wiser use of the foundations furnished by the kindergarten. The drawing and the paper folding must lead on directly to systematic study of intuitional geometry, including the construction of models and the elements of mechanical drawing, with simple exercises in geometrical reasoning.* The geometry must be closely connected with the numerical and literal arithmetic. The cross-grooved tables of the kindergarten furnish an especially important type of connection, viz., a conventional graphical depiction of any phenomenon in which one magnitude depends upon another. These tables and the similar cross-section blackboards and paper must enter largely into all the mathematics of the grades. The children are to be taught to represent, according to the usual conventions, various familiar and interesting phenomena and to study the properties of the phenomena in the pictures: to know, for example, what concrete meaning attaches to the fact that a graph curve at a certain point is going down or going up or is horizontal. Thus the problems of percentage—interest, etc.—have their depiction in straight line or broken line graphs.

* As to the mathematics of these institutions, one may consult the book on 'The Teaching of Mathematics in the Higher Schools of Prussia' (New York, Longmans, Green & Co., 1900) by Professor Young, and the article (*Bulletin Amer. Math. Soc.* (2), vol. 6, p. 225) by Professor Pierpont.

* Here I refer to the very suggestive paper of Benchara Branford, entitled 'Measurement and Simple Surveying. An Experiment in the Teaching of Elementary Geometry' to a small class of beginners of about ten years of age (*Journal of Education*, London, the first part appearing in the number for August, 1899).

The Secondary Schools.—Pending the reform of the primary schools, the secondary schools must advance independently. In these schools at present, according to one type of arrangement, we find algebra in the first year, plane geometry in the second, physics in the third, and the more difficult parts of algebra and solid geometry, with review of all the mathematics, in the fourth.

Engineers* tell us that in the schools algebra is taught in one water-tight compartment, geometry in another, and physics in another, and that the student learns to appreciate (if ever) only very late the absolutely close connection between these different subjects, and then, if he credits the fraternity of teachers with knowing the closeness of this relation, he blames them most heartily for their unaccountably stupid way of teaching him. If we contrast this state of affairs with the state of affairs in the solid four years' course in Latin, I think we are forced to the conclusion that the organization of instruction in Latin is much more perfect than that of the instruction in mathematics.

The following question arises: *Would it not be possible to organize the algebra, geometry and physics of the secondary school into a thoroughly coherent four years' course,* comparable in strength and closeness of structure with the four years' course in Latin? (Here under physics I include astronomy and the more mathematical and physical parts of physiography.) It would seem desirable that, just as the systematic development of theoretical mathematics is deferred to a later period, likewise much of theoretical physics might well be deferred. Let the physics also be made thoroughly practical. At any rate, so far as the instruction of boys is concerned, the course should certainly have its character largely determined by the conditions which would be imposed by engineers. What kind of two or three years' course in mathematics and physics would a thoroughly trained engineer give to boys in the secondary school? Let this body of material postulated by the engineer serve as the basis of the four years' course. Let the instruction in the course, however, be given by men who have received expert training in mathematics and physics as well as in engineering, and let the instruction be so organized that with the development of the boy, in appreciation of the practical relations, shall come simultaneously his development in the direction of theoretical physics and theoretical mathematics.

Perry is quite right in insisting that it is scientifically legitimate in the pedagogy of elementary mathematics to take a large body of basal principles instead of a small body, and to build the edifice upon the larger body for the earlier years, reserving for the later years the philosophic criticism of the basis itself and the reduction of the basal system.

* Why is it that one of the sanest and best-informed scientific men living, a man not himself an engineer, can charge mathematicians with killing off every engineering school on which they can lay hands? Why do engineers so strongly urge that the mathematical courses in engineering schools be given by practical engineers?

And why can a reviewer of 'Some Recent Books of Mechanics' write with truth: "The students' previous training in algebra, geometry, trigonometry, analytic geometry and calculus as it is generally taught has been necessarily quite formal. These mighty algorithms of formal mathematics must be learned so that they can be applied with readiness and precision. But with mechanics comes the application of these algorithms, and formal, do-by-rote methods, though often possible, yield no results of permanent value. How to elicit and cultivate thought is now of primary importance"? (E. B. Wilson, *Bulletin Amer. Math. Soc.*, October, 1902.) But is it conceivable that in any part of the education of the student the problem of eliciting and cultivating thought should not be of primary importance?

To consider the subject of geometry in all briefness: with the understanding that proper emphasis is laid upon all the concrete sides of the subject, and that furthermore from the beginning exercises in informal deduction* are introduced increasingly frequently, when it comes to the beginning of the more formal deductive geometry why should not the students be directed each for himself to set forth a body of geometric fundamental principles, on which he would proceed to erect his geometric edifice? This method would be thoroughly practical and at the same time thoroughly scientific. The various students would have different systems of axioms, and the discussions thus arising naturally would make clearer in the minds of all precisely what are the functions of the axioms in the theory of geometry. The students would omit very many of the axioms, which to them would go without saying. The teacher would do well not to undertake to make the system of axioms thoroughly complete in the abstract sense. "Sufficient unto the day is the precision thereof." The student would very probably wish to take for granted all the ordinary properties of measurement and of motion, and would be ready at once to accept the geometrical implications of coordinate geometry. He could then be brought with extreme ease to the consideration of fundamental notions of the calculus as treated concretely, and he would find those notions delightfully real and powerful, whether in the domain of mathematics or of physics or of chemistry.

* In an article shortly to appear in the *Educational Review*, on 'The Psychological and the Logical in the Teaching of Geometry,' Professor John Dewey, calling attention to the evolutionary character of the education of an individual, insists that there should be no abrupt transition from the introductory, intuitional geometry to the systematic, demonstrative geometry.

To be sure, as Study has well insisted, for a thorough comprehension of even the elementary parts of euclidean geometry the non-euclidean geometries are absolutely essential. But the teacher is teaching the subject for the benefit of the students, and it must be admitted that beginners in the study of demonstrative geometry can not appreciate the very delicate considerations involved in the thoroughly abstract science. Indeed, one may conjecture that, had it not been for the brilliant success of Euclid in his effort to organize into a formally deductive system the geometric treasures of his times, the advent of the reign of science in the modern sense might not have been so long deferred. Shall we then hold that in the schools the teaching of demonstrative geometry should be reformed in such a way as to take account of all the wonderful discoveries which have been made—many even recently—in the domain of abstract geometry? And should similar reforms be made in the treatment of arithmetic and algebra? To make reforms of this kind, would it not be to repeat more gloriously the error of those followers of Euclid who fixed his 'Elements' as a textbook for elementary instruction in geometry for over two thousand years? Every one agrees that professional mathematicians should certainly take account of these great developments in the technical foundations of mathematics, and that ample provision should be made for instruction in these matters; and on reflection, every one agrees further that this provision should be reserved for the later collegiate and university years.

The Laboratory Method.—This program of reform calls for the development of a thoroughgoing laboratory system of instruction in mathematics and physics, a principal purpose being as far as possible to develop on the part of every student the true spirit of research, and an appreciation,

practical as well as theoretic, of the fundamental methods of science.

In connection with what has already been said, the general suggestions I now add will, I hope, be found of use when one enters upon the questions of detail involved in the organization of the course.

As the world of phenomena receives attention by the individual, the phenomena are described both graphically and in terms of number and measure; the number and measure relations of the phenomena enter fundamentally into the graphical depiction, and furthermore the graphical depiction of the phenomena serves powerfully to illuminate the relations of number and measure. This is the fundamental scientific point of view. Here under the term graphical depiction I include representation by models.

To provide for the needs of laboratory instruction, there should be regularly assigned to the subject two periods, counting as one period in the curriculum.

As to the possibility of effecting this unification of mathematics and physics in the secondary schools, objection will be made by some teachers that it is impossible to do well more than one thing at a time. This pedagogic principle of concentration is undoubtedly sound. One must, however, learn how to apply it wisely. For instance, in the physical laboratory it is undesirable to introduce experiments which teach the use of the calipers or of the vernier or of the slide rule. Instead of such uninteresting experiments of limited purpose, the students should be directed to extremely interesting problems which involve the use of these instruments, and thus be led to learn to use the instruments as a matter of course, and not as a matter of difficulty. Just so the smaller elements of mathematical routine can be made to attach themselves to laboratory problems, arousing and retaining the interest of the students. Again, everything exists in its relations to other things, and in teaching the one thing the teacher must illuminate these relations.

Every result of importance should be obtained by at least two distinct methods, and every result of especial importance by two essentially distinct methods. This is possible in mathematics and the physical sciences, and thus the student is made thoroughly independent of all authority.

All results should be checked, if only qualitatively or if only 'to the first significant figure.' In setting problems in practical mathematics (arithmetical computation or geometrical construction) the teacher should indicate the amount or percentage of error permitted in the final result. If this amount of percentage is chosen conveniently in the different examples, the student will be led to the general notion of closer and closer approximation to a perfectly definite result, and thus in a practical way to the fundamental notions of the theory of limits and of irrational numbers. Thus, for instance, uniformity of convergence can be taught beautifully in connection with the concrete notion of area under a monotonic curve between two ordinates, by a figure due to Newton, while the interest will be still greater if in the diagram area stands for work done by an engine.

The teacher should lead up to an important theorem gradually in such a way that the precise meaning of the statement in question, and further, the practical—*i. e.*, computational or graphical or experimental—truth of the theorem is fully appreciated; and, furthermore, the importance of the theorem is understood, and, indeed, the desire for the formal proof of the proposition is awakened, before the formal proof itself is developed. Indeed, in most cases, much of the proof should be secured

by the research work of the students themselves.

Some hold that absolutely individual instruction is the ideal, and a laboratory method has sometimes been used for the purpose of attaining this ideal. The laboratory method has as one of its elements of great value the flexibility which permits students to be handled as individuals or in groups. The instructor utilizes all the experience and insight of the whole body of students. He arranges it so that the students consider that they are studying the subject itself, and not the words, either printed or oral, of any authority on the subject. And in this study they should be in the closest cooperation with one another and with their instructor, who is in a desirable sense one of them and their leader. Instructors may fear that the brighter students will suffer if encouraged to spend time in cooperation with those not so bright. But experience shows that just as every teacher learns by teaching, so even the brightest students will find themselves much the gainers for this cooperation with their colleagues.

In agreement with Perry, it would seem possible that the student might be brought into vital relation with the fundamental elements of trigonometry, analytic geometry and the calculus, on condition that the whole treatment in its origin is and in its development remains closely associated with thoroughly concrete phenomena. With the momentum of such practical education in the methods of research in the secondary school, the college students would be ready to proceed rapidly and deeply in any direction in which their personal interests might lead them. In particular, for instance, one might expect to find effective interest on the part of college students in the most formal abstract mathematics.

For all students who are intending to take a full secondary school course in preparation for colleges or technological schools, I am convinced that the laboratory method of instruction in mathematics and physics, which has been briefly suggested, is the best method of instruction—for students in general, and for students expecting to specialize in pure mathematics, in pure physics, in mathematical physics or astronomy, or in any branch of engineering.

Evolution, not Revolution.—In contemplating this reform of secondary school instruction we must be careful to remember that it is to be accomplished as an evolution from the present system, and not as a revolution of that system. Even under the present organization of the curriculum the teachers will find that much improvement can be made by closer cooperation one with another; by the introduction, so far as possible, of the laboratory two-period plan; and in any event by the introduction of laboratory methods: laboratory record books, cross-section paper, computational and graphical methods in general, including the use of colored inks and chalks; the cooperation of students; and by laying emphasis upon the comprehension of propositions rather than upon the exhibition of comprehension.

The Junior Colleges.—Just as the secondary schools should begin to reform without waiting for the improvement of the primary schools, so the elementary collegiate courses should be modified at once without waiting for the reform of the secondary schools. And naturally, in the initial period of reform, the education in each higher domain will involve many elements which later on will be transferred to a lower domain.

Further, by the introduction into the junior colleges of the laboratory method of instruction it will be possible for the colleges and universities to take up a duty which for the most part has been neglected

in this country. For, although we have normal schools and other training schools for those who expect to teach in the grades, little attention has as yet been given to the training of those who will become secondary school teachers. The better secondary schools to-day are securing the services of college graduates who have devoted special attention to the subjects which they intend to teach, and as time goes on the positions in these schools will as a rule be filled (as in France and Germany) by those who have supplemented their college course by several years of university work. Here these college and university graduates proceed at once to their work in the secondary schools. Now in the laboratory courses of the junior college, let those students of the senior college and graduate school who are to go into the teaching career be given training in the pedagogy of mathematics according to the laboratory system; for such a student the laboratory would be a laboratory in the pedagogy of mathematics; that is, he would be a colleague-assistant of the instructor. By this arrangement, the laboratory instruction of the colleges would be strengthened at the same time that well equipped teachers would be prepared for work in the secondary schools.

The Freedom of the Secondary Schools.—The secondary schools are everywhere preparing students for colleges and technological schools, and whether the requirements of those institutions are expressed by way of examination of students or by way of the conditions for the accrediting of schools or teachers, the requirements must be met by the secondary schools. The stronger secondary school teachers too often find themselves shackled by the specific requirements imposed by local or by collegiate authorities. Teaching must become more of a profession. And this implies not only that the teacher must be better trained for his career, but that also in his career he be given with greater freedom greater responsibility. To this end closer relations should be established between the teachers of the colleges and those of the secondary schools; standing provisions should be made for conferences as to improvement of the secondary school curricula and in the collegiate admission requirements; and the leading secondary school teachers should be steadily encouraged to devise and try out plans looking in any way toward improvement.

Thus the proposed four years' laboratory course in mathematics and physics will come into existence by way of evolution. In a large secondary school, the strongest teachers, finding the project desirable and feasible, will establish such a course alongside the present series of disconnected courses—and as time goes on their success will in the first place stimulate their colleagues to radical improvements of method under the present organization and finally to a complete reorganization of the courses in mathematics and physics.

The American Mathematical Society.—Do you not feel with me that the American Mathematical Society, as the organic representative of the highest interests of mathematics in this country, should be directly related with the movement of reform? And, to this end, that the society, enlarging its membership by the introduction of a large body of the strongest teachers of mathematics in the secondary schools, should give continuous attention to the question of improvement of education in mathematics, in institutions of all grades? That there is need for the careful consideration of such questions by the united body of experts, there is no doubt whatever, whether or not the general suggestions which we have been considering this afternoon turn out to be desirable and practicable. In case the question of pedagogy

does come to be an active one, the society might readily hold its meetings in two divisions—a division of research and a division of pedagogy.

Furthermore, there is evident need of a national organization having its center of gravity in the whole body of science instructors in the secondary schools; and those of us interested in these questions will naturally relate ourselves also to this organization. It is possible that the newly formed Central Association of Physics Teachers may be the nucleus of such an organization.

CONCLUSION.

The successful execution of the reforms proposed would seem to be of fundamental importance to the development of mathematics in this country. I urge that individuals and organizations proceed to the consideration of the general question of reform with all the related questions of detail. Undoubtedly in many parts of the country improvements in organization and methods of instruction in mathematics have been making these last years. All persons who are, or may become, actively interested in this movement of reform should in some way unite themselves, in order that the plans and the experience, whether of success or failure, of one may be immediately made available in the guidance of his colleagues.

I may refer to the centers of activity with which I am acquainted. Miss Edith Long, in charge of the Department of Mathematics in the Lincoln (Neb.) High School, reports upon the experience of several years in the correlation of algebra, geometry and physics, in the October, 1902, number of the *Educational Review*. In the Lewis Institute of Chicago, Professor P. B. Woodworth, of the Department of Electrical Engineering, has organized courses in engineering principles and electrical engineering in which are developed the fundamentals of practical mathematics. The general question came up at the first meeting* (Chicago, November, 1902) of the Central Association of Physics Teachers, and it is to be expected that this association will enlarge its functions in such a way as to include teachers of mathematics and of all sciences, and that the question will be considered in its various bearings by the enlarged association. At this meeting informal reports were made from the Bradley Polytechnic Institute of Peoria, the Armour Institute of Technology of Chicago, and the University of Chicago. The question is evoking much interest in the neighborhood of Chicago.

I might explain how I came to be attracted to this question of pedagogy of elementary mathematics. I wish, however, merely to express my gratitude to many mathematical and scientific friends, in particular, to my Chicago colleagues, Mr. A. C. Lunn and Professor C. R. Mann, for their cooperation with me in the consideration of these matters, and further to express the hope that we may secure the active cooperation of many colleagues in the domains of science and of administration, so that the first carefully chosen steps of a really important advance movement may be taken in the near future.

I close by repeating the questions which have been engaging our attention this afternoon.

In the development of the individual in his relations to the world, there is no initial separation of science into constituent parts, while there is ultimately a branching into the many distinct sciences.

* Subsequent to the meeting of organization in the spring of 1902. Mr. Chas. H. Smith of the Hyde Park High School, Chicago, is president of the Association. Reports of the meetings are given in *School Science* (Ravenswood, Chicago).

The troublesome problem of the closer relation of pure mathematics to its applications: can it not be solved by indirection, in that through the whole course of elementary mathematics, including the introduction to the calculus, there be recognized in the organization of the curriculum no distinction between the various branches of pure mathematics, and likewise no distinction between pure mathematics and its principal applications? Further, from the standpoint of pure mathematics: will not the twentieth century find it possible to give to young students during their impressionable years, in thoroughly concrete and captivating form, the wonderful new notions of the seventeenth century?

By way of suggestion these questions have been answered in the affirmative, on condition that there be established a thoroughgoing laboratory system of instruction in primary schools, secondary schools and junior colleges—a laboratory system involving a synthesis and development of the best pedagogic methods at present in use in mathematics and the physical sciences.

ELIAKIM HASTINGS MOORE.

UNIVERSITY OF CHICAGO.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. SECTION C, CHEMISTRY.

THE meetings of Section C were held jointly with those of the American Chemical Society on December 29, 30 and 31, in the Medical Building of Columbian University. The meetings on the first two days were in charge of the officers of the American Chemical Society, Dr. Ira Remsen, president of the society, presiding. On the third day Vice-President Baskerville presided. The address of the retiring vice-president, Dr. H. A. Weber, on 'Incomplete Observations,' was delivered on Monday, December 29. The newly elected sectional officers are:

Vice-President—Dr. W. D. Bancroft, of Cornell University.

Secretary—C. L. Parsons, of Durham, N. H.

Members of the Sectional Committee—A. S. Wheeler, E. C. Franklin, M. T. Bogert, L. P. Kinnicutt and L. Kahlenberg.

Among the papers read were the following:

Corrosion of some Ancient Coins: F. P. DUNNINGTON, University of Virginia, Charlottesville, Va.

About fifteen years ago the late Judge Victor Clay Barringer was living in Alexandria, Egypt, when an extensive fire occurred. After this fire he bought from a native a mass which appeared to consist of corroded copper, which he was told had been obtained from a hole in a wall where a building had been demolished in the conflagration. This compacted green cylindrical mass of about twenty pounds weight was kept as a hearth ornament, and not examined until it recently came into the possession of Dr. Paul B. Barringer, of the University of Virginia. The mass then bore the imprint of the woven bag in which it had been confined and proved to be composed of coins in various stages of corrosion.

The author was requested to clean off a number of the coins, of which there were probably 500, and so far as examined, all prove to have belonged to the reigns of the Cæsars and to have had the same composition and approximately the same weight, about fifteen grams each. The unaltered red metal consists of silver and copper, containing, as shown by several samples, almost exactly one part of silver to four of copper, which, when partially attacked by dipping in acid, loses a portion of copper and leaves a larger proportion of silver on the surface, and thereafter continues to 'wear' as a white metal, evidently having passed as 'silver coin.'

The crust of malachite which firmly bound these pieces together varied in thickness up to two millimeters, and within this there was a layer of red oxide of copper of similar thickness which is almost free of silver, containing but about one per cent. Inside of these two crusts there remained more or less of a dark spongy mass of silver, retaining a little oxide of copper which adhered to the unchanged alloy, and in some instances the latter had entirely disappeared, so that this residue of the coin was fragile while still partly retaining the imprint of the coin. The manner in which the silver was concentrated is of decided interest.

From the contents and circumstances of this find these coins had no doubt been thus stored away for nearly 1,900 years, and yet on most of them the lettering and even the dates may be deciphered.

A Convenient Form of Table for Calculations of Chemical Weights: F. P. DUNNINGTON, University of Virginia.

The author, having frequent occasion to check calculations of the amounts of substances from the weights made by students in quantitative analysis, has constructed a table to enable him quickly to obtain such results. A description of this is given to the section as a proposed accessory in teaching, which may prove instructive to the pupil and helpful to the teacher.

Upon coordinate paper 500 by 400 mm. the 500 mm. abscissa is counted as 1,000, and there is laid off upon the (vertical) ordinate the length corresponding to the figure expressing the amount of body sought for each 1,000 parts of the substance found. A straight line is then drawn from the origin to this point, as 798 for the copper in 1,000 of CuO, or 247 for the chlorine in silver chloride.

Similarly a diagonal line is drawn from the origin for each such form in which bodies are weighed. If, then, one reads off upon the abscissa the measure corresponding to any weight of substance found, the length of the ordinate at that point which is cut off by the corresponding diagonal gives directly the amount of the body sought. For instance, .679 of MnS gives .429 of Mn.

The Action of Unsymmetrical Hydrazines on the Chlorine Derivatives of the Quinones of the Benzene Series: WILLIAM MCPHERSON, W. L. DUBOIS and C. P. LINVILLE.

The unsymmetrical acyl phenyl hydrazines react with the different chlor-quinones in the following ways: (1) A regular condensation may take place forming the corresponding hydrazones, which on saponification yield oxyazo-compounds. (2) A hydrogen atom of the quinone together with a hydrogen atom of NH_2 group of the hydrazine may be removed by the oxidizing action of the quinone, forming a hydrazino compound. (3) A chlorine atom of the quinone may combine with a hydrogen atom of the NH_2 group of the hydrazine, a hydrazino compound being formed with the evolution of hydrochloric acid.

Some New Phenomena Exhibited by Soap Solutions: H. W. HILLYER.

As the formation of bubbles is dependent on the low surface tension of soap solution, so the emulsifying power of soap solutions is largely dependent on the low surface tension between the soap solution and the oily matter removed by it. This lowering of the surface tension is, within certain limits, nearly proportional to the amount of soap in solution. Neither of the hydrolytic products of soap, *i. e.*, alkali or fatty acid, causes this lowering of the surface tension; it is a measure of the amount of *soap* present. Emulsification is

dependent almost directly on the smallness of the surface tension, and this largely explains the cleansing power of soap. A practical soap test from the consumer's standpoint is clearly indicated, but not yet fully worked out.

Charts, diagrams and specimens were shown.

The Composition of Spirits Produced from Grain, and the Changes Undergone by the Same when Stored in Wooden Packages: Charles A. Crampton, Int. Rev., Treasury Dept., Washington, D. C.

Analyses are given of samples of rye and bourbon whiskies, taken each year from packages set aside in government warehouses, for the purpose of determining the effect of time upon the composition of the spirits. The purpose of the experiments is to obtain analytical data upon which genuine whiskies aged without foreign addition can be distinguished from spurious spirits made by coloring matter and artificial flavors to alcohol or cologne spirits. The present paper is a preliminary report of the results obtained for the first four years of storage. The experiments will be continued and complete results and conclusions published at some future date.

Some Double Salts of Organic Acids: Jas. Lewis Howe, Lexington, Va.

Aside from the chrom-oxalates, and oxalates of the platinum metals, few complex salts of organic acids have been studied. A qualitative investigation shows that quite a number of other acids form similar salts. A series of chrom-malonates is described. Attempts made to prepare similar complex salts of trivalent cobalt by electrolytic oxidation. Several of the double cobalto-salts are not oxidized by the electric current. A series of double cobalto-malonates were prepared and are described. These are oxidized to complex cobalti-malonates, and these are now being studied.

Preparation of Standard Solutions of Sulphuric Acid by Direct Dilution: Arthur John Hopkins.

According to the table of Marignac the coefficient of expansion for sulphuric acid of sp. gr. 1,263 is found to be constant between 15° and 20°. Accordingly a stock acid is prepared as near to sp. gr. 1.263 as possible, and its exact specific gravity accurately determined.

A table is prepared for this stock acid showing at different working temperatures the exact volume necessary to dilute to one liter in order to prepare, *e. g.*, a tenth-normal acid. This table is prepared from the work of Lunge and Isler on the valuation of acid of different specific gravities and from the work of Marignac, allowance being made for the expansion of glass.

The preparation of a tenth-normal acid, consists in allowing to flow from a salibrated burette the volume of acid, indicated in the table for the working temperature, into a flask known to contain exactly one liter, and diluting to the mark.

Condensation of Triphenylmethyl to Hexaphenylethane: M. Gomberg, Ann Arbor, Mich.

It has been established that certain halogen derivatives have the power to condense triphenylmethyl to the saturated hydrocarbon hexaphenylethane.

Methods for the Examination of Bitumens and their Determination and Separation: Clifford Richardson, Long Island City, N. Y. Read by title.

In the course of fifteen years' experience, in the application of bitumens in the industries, a large number of methods for the examination and determination of this material have been developed, and are de-

scribed in the paper as a contribution to the literature of the subject.

Portland Cement, Considered as a Solid Solution: CLIFFORD RICHARDSON, Long Island City, N. Y. Read by title.

While the literature on the subject of the constitution of Portland cement is very extensive, in reviewing the same the writer has discovered that the conclusions which have been arrived at are neither uniform nor supported by satisfactory evidence of a synthetic nature. He has, therefore, prepared in the laboratory all those silicates and silico-aluminates which are supposed, according to the theory of various writers, to occur in Portland cement clinker. The results of a study of these preparations under the microscope, by petrographic methods, and in their relations to water, show that many of the theories heretofore advanced are unsound, and the Portland cement must be considered to be a type of solid solution, as it presents features quite similar to those found in alloys of the metals.

A Characterization, Classification and Nomenclature of Native Bitumens: CLIFFORD RICHARDSON, Long Island City, N. Y. Read by title.

This paper has been written because of the appointment of a committee, by the International Association for Testing Materials, on the subject of the nomenclature of bitumen.

Many classifications of the native bitumens have been attempted in the past, but they have been based upon insufficient data. During the past ten years the writer has had an opportunity to examine a very large number of native bitumens, and to compare them with type specimens, which are now generally unavailable, through the exhaustion of the mines. The evidence accumulated in this way forms the basis of the proposals contained in the paper.

In the course of the examination grahamite, which has hitherto been described as only coming from West Virginia, has been found to occur in an easily recognizable form in Colorado, Indian Territory, Cuba, Trinidad and Mexico; albertite, in Utah and several other localities; and various types of asphalt in some 200 or 300 different localities.

The evidence thus obtained has been carefully analyzed, and the following classification of the native bitumens deduced:

BITUMENS:
- *Gas:*
  - Natural gas.
  - Marsh gas.
- *Petroleum.*
  - Paraffine oils.
    - Rich in sulphur derivatives.
    - Poor in sulphur derivatives.
  - Cyclic oils.
    - Russian, stable polymethylenes.
    - Californian, asphaltic polymethylenes.
  - Mixed oils.
    - Containing both paraffine and cyclic hydrocarbons.
- *Maltha.*
- *Solid Bitumens:*
  - Originating in paraffine hydrocarbons.
    - Ozocerite, hatchetite, etc.
  - Originating in cyclic hydrocarbons.
    - Terpenes, fossil resins, amber, etc.
  - Polymethylenes and their derivatives.
    - Gilsonites.
    - Asphalts, including glance pitch.
    - Grahamites (asphaltites).
  - Individual species.
    - Manjak.
  - Uvalde County, Texas, bitumen, etc.
  - The grahamites rapidly shade into the pyrobitumens.

Pyrobitumens:

Practically insoluble in chloroform or heavy petroleum hydrocarbons.

1. Derived from petroleum.
   Albertite, with varieties called nigrite, etc.
   Elaterite.
   Wurtzelite.
2. Derived from direct metamorphosis of vegetable growth.
   Anthracite.
   Bituminous coal.
   Lignite.
   Peat?

The following papers were also read:

Some of the Work of the Bio-Chemic Division, Department of Agriculture: E. A. DE SCHWEINITZ.

Does Cholesterol Occur in Corn Oil? A. H. GILL.

Miley's Color Photography: W. G. BROWN.

The Composition of Fresh and Canned Pineapples: L. S. MUNSON and L. M. TOLMAN.

Chemical Composition of some Tropical Fruits and Fruit Products: E. M. CHASE, L. S. MUNSON and L. M. TOLMAN.

Nature of the Work of the Bureau of Chemistry, Department of Agriculture: H. W. WILEY.

Iodine Absorption of Oils; Comparison of Methods: L. M. TOLMAN and L. S. MUNSON.

The Relation of the Specific Gravity of Urine to the Solids Present: JOHN H. LONG.

Derivatives of Isoapiol and Isosafrol: F. J. POND. Read by title.

Report of the Committee on Atomic Weights: F. W. CLARKE.

Report of the International Committee on Atomic Weights: F. W. CLARKE.

On the Need of Systematic Action regarding the Question of Substitution and Adulteration: LEON L. WATTERS. Read by title.

The Chemical Work of the Bureau of Soils, Department of Agriculture: FRANK K. CAMERON.

The Action of Metallic Magnesium on Aqueous Solutions: LOUIS KAHLENBERG.

Action upon Metals of Solutions of Hydrochloric Acid in Various Solvents: HARRISON E. PATTEN.

A Proposed Method of Examining Wood Treated to Resist Fire: C. F. MCKENNA.

An Electric Test Retort: C. F. MCKENNA.

The Basic Sulphates of Beryllium: CHAS. LATHROP PARSONS.

The Picrates of the Rare Earths: L. M. DENNIS and W. C. GEER.

The Chemical Work of the U. S. Geological Survey: F. W. CLARKE.

A Method for the Colorimetric Determination of Phosphates and Silicates when Both are Present: OSWALD SCHREINER.

A New (?) Meteorite from Augusta County, Virginia: H. D. CAMPBELL and JAS. LEWIS HOWE.

A Volumetric Method for the Determination of Chromic Acid in Chrome Pigments: E. E. EWELL.

Suggested Improvement in Chlorine Determination: CHAS. BASKERVILLE.

The Determination of the Hydrocarbons in Illuminating Gas: L. M. DENNIS and J. G. O'NEILL.

Reduction with Soluble Anodes: WILDER D. BANCROFT.

Solubility Curves for Magnesium Carbonate in Aqueous Solutions of Sodium Chloride, Sodium Sulphate and Sodium Carbonate: FRANK K. CAMERON and ATHERTON SEIDELL.

The Optical Rotating Power of Camphor Dissolved in Inorganic Solvents: Phosphorus Trichloride, Sulphur Dioxide, Sulphur Monochloride: HERMAN SCHLUNDT.

Report of Committee on Atomic Weight of Thorium: CHAS. BASKERVILLE.

New Syntheses in the Phenmiazine Group: MARSTON TAYLOR BOGERT.

Some Picryl Derivatives of Phenols: H. W. HILLYER.

Nomenclature of Elements and Radicals: W. G. BROWN.

Hydrochloric Acid as an Electrolytic Solvent: E. C. FRANKLIN.

H. N. STOKES,
Secretary.

SCIENTIFIC BOOKS.

The Development of the Human Body, A Manual of Human Embryology. By J. PLAYFAIR MCMURRICH. With two hundred and seventy illustrations. 12mo. Pp. xvi + 527.

The author in his preface describes his book as 'an attempt to present a concise statement of the development of the human body and a foundation for the proper understanding of the facts of anatomy.' This attempt has been so far successful that the volume is certainly the best short treatise on human embryology in English, and is not surpassed by any of the text-books in foreign languages. It has the distinguishing merit of including a number of important results from recent investigations, which have as yet made their way into no other manual.

The work is really shorter and more condensed than might be supposed from the number of pages, for the type used is large and open and the illustrations, owing to their large size, take up much space. Some of the figures, like Fig. 54, are unnecessarily large. They are, on the whole, well printed, although the ink used is too heavy to give the best effect. The selection of figures has been excellent. Except for a series of diagrams, very few of them are original, by far the majority of the illustrations being copies, not, one is glad to note, from previous text-books, but from the best recent researches.

The author's style is well adapted to his purpose, for it is both concise and clear, revealing, indeed, a marked talent for lucid explanations of the complicated changes which occur in such rapid succession in the embryo, and which render the study of embryology so difficult.

The book would have certainly gained very much had it been less a compilation from well-chosen authorities, and more the outcome of the author's personal study of human embryos. As a compilation it is to be praised warmly, but one misses somehow that vividness of exposition which direct familiarity with preparations, sections and dissections alone can impart to morphological descriptions. One misses also the security of judgment which can be derived from first-hand and intimate acquaintance with the object. To this cause we attribute the author's failure to utilize at all adequately our knowledge of the histogenesis of the nervous system, to consider the relation of the nails to the stratum lucidum, to give any mention of the meninges which offer such striking pictures in sections of embryos, to remember that a mucous membrane always comprises epithelium and mesoderm (cf. p. 79), to describe correctly the degeneration of the glandular epithelium in the pregnant uterus (p. 151, 153), etc.

There are certain errors which mar the work. In the history of germ-cells it is stated positively that the germ-cells produce the spermatozoa, but so far as we know this has not been proved as yet by direct observation to be true of any animal. It is surely no longer correct to speak (p. 122) of the 'branchiomeres' as divisions of the ventral mesoderm, since they arise, so far as yet observed, always from the dorsal segments. It is stated (p. 153) that the decidua serotina 'loses its epithelium very early'—but portions of the epithelium are always persistent. Or again the statement that the processes of the vertebræ and ribs are developed in the intermuscular septa hardly concords with the actual history.

In a new edition, which ought certainly soon to be demanded, two omissions might be advantageously repaired, by adding accounts of the development of the ear bones and of the pulmonary arteries.

The defects, of which some examples have been given, can not any of them be regarded as fundamental. Some such defects are inevitable in a first edition of a text-book dealing with a science, like embryology, in which research is so active that almost every week brings important additions to knowledge of the subject. The only part of the work which seems to the reviewer radically inadequate is that on the formation of the germ-layers.

Professor McMurrich's volume will be eagerly welcomed by students and teachers alike, and its special distinction is the thorough recognition it displays of the morphologically essential aspects of embryology. It ought to exert a wide and helpful influence on the advancement of anatomical science in America.

C. S. Minot.

Field Astronomy for Engineers. By George C. Comstock. New York, Wiley & Sons. 1902. Pp. x + 202. Price, $2.50.

Wiley & Sons have just published an excellent text-book on astronomy written by Professor George C. Comstock, professor of astronomy in the University of Wisconsin, a text-book which undoubtedly will meet with cordial approval from that body of teachers whose duty it is to teach astronomy in technical schools. For many years there existed no concise manual of the subject, the teacher being obliged either to use an elaborate treatise like Chauvenet's, or else employ the unsatisfactory method of presenting the subject entirely by lectures. The present work is the third attempt to supply the deficiency, other similar publications of recent date being those of J. F. Hayford, formerly of Cornell University and now of the U. S. Coast Survey, and of W. W. Campbell, director of the Lick Observatory.

The peculiarity and advantage of the present book are that it omits entirely that portion of the astronomical theory and instrumental niceties beyond the needs of engineering students and, on the other hand, lays special stress on the methods by which only sufficient precision is attained to meet engineering requirements. This general plan of the author enables him to discuss, and he does it with much skill, the question of the inter-relation of accuracy of results with instrumental manipulation, and should give the student a clear insight into the proper methods and formulæ to use on any particular occasion. At the same time the author emphasizes the necessity of methodical computation and insists on a habit of checks, so desirable a habit for engineers in all kinds of computations. In some cases it may be necessary to elaborate verbally some of the theory involved, and to explain, as doubtless the author does to his own classes, much of the instrumental manipulation, so that the book is essentially one to be used by an instructor whose own astronomical training includes much not in the book; but as this is always, at least theoretically, the case, it should not stand as a criticism against the book.

The plan of the book includes, after a discussion of the fundamental concepts of coordinates and the transformation of one system into another and of the various methods of noting them, methods of observation and computation for the determination of time, latitude and azimuth. Each determination is carried out according to the requirements, either roughly, approximately or accurately, in each case modifying the formulæ and the use of instruments as required. For example, for the rough determination of time, use is made of an engineer's transit to observe on Polaris at any instant, the correction to the meridian being given by the use of tables. For the approximate determination, the method given is that of making a series of altitude observations with a sextant on a known star or on the sun when that body is near the prime vertical. For the accurate determination, the method of double altitudes is explained, and a whole chapter is devoted to discussing the transit instrument with its errors and corrections. In each of these cases, as well as in the similar series for latitude and azimuth, the detail of work, the

proper form for notes, suggestions for computations, and the probable error of the result are all given in a satisfactory manner.

Altogether, the book is a careful evidence of a thorough appreciation of the needs of engineering students and of the comprehensive knowledge of the distinguished author.

H. N. OGDEN.

CORNELL UNIVERSITY.

PROFESSOR HEILPRIN ON MONT PELÉE.

THE twentieth century Pompeii in Martinique attracted men of science from all points of the compass. Notes have been published by Lacroix in Paris, Flett and Anderson in London and Hovey in New York, and magazine articles by Russell, Hill, Diller, Curtis and others have familiarized the public with the main facts. Two books of note have appeared, the one by a distinguished traveller and correspondent describing vividly and accurately a layman's impressions of the phenomena and the wreck. The second, entitled 'Mont Pelée and the Tragedy of Martinique,'* is by a well-known geologist and geographer, Angelo Heilprin, and his work is the first book that purports to be a scientific study.

The book was published in December, 1902, and the author had left the field only three months before. In view of this fact the work is a remarkable piece of rapid book-making, well executed by the publishers, and illustrated with half-tone photographs. It is essentially the journal of an explorer, with records compiled in the field of the disasters of May 7 and 8, and four scientific essays. The subjects treated are the author's impressions of Martinique, a description of the ruins of St. Pierre, the narrative of the last days of the city, the author's travels in the interior, his ascent of Pelée at the end of May and his second visit to Martinique in August. Professor Heilprin personally observed the great eruption of August 30, and from a distance he saw the eruption in St. Vincent September 3. His experience in August is especially valuable and unique, because at that time he kept the only scientific record.

* J. B. Lippincott Co., Philadelphia, 1903, pp. 336.

The scientific chapters deal with a comparison of St. Pierre and Pompeii, the geography of Mont Pelée, volcanic relations of the Caribbean basin and the phenomena of the eruptions. In the first of these Pliny's account of the Vesuvian eruption of 79 is discussed; Dion Cassius and later historians refer the destruction of life and property in Pompeii to ashes, cinders and gases. The tumble of ruins in Pompeii has commonly been attributed to earthquakes, but it is possible that there too a destroying blast annihilated the population almost instantly, as in St. Pierre; this accounts for bodies found in attitudes of action or indifference to danger. Heilprin questions the decapitation of Monte Somma at the time of the eruption of 79; he calls attention to Pliny's description of the phenomena as follows: 'On the land side a dark and horrible cloud charged with combustible matter suddenly broke and shot forth a long trail of fire in the nature of lightning, but in larger flashes.' And again, "I looked back; a thick dark vapor just behind us rolled along the ground like a torrent and followed us. The ashes now began falling, although in no considerable quantity." The similarity of this description to that of bystanders in the case of the Caribbean eruption is remarkable. The fact that Pompeiian bodies are largely without clothing, and were huddled together in basements, and that pottery and glassware have been found deformed and discolored, suggests that there was a hurricane blast and conflagration similar to the one which destroyed St. Pierre.

It is questionable whether the Lac des Palmistes, on the summit of Mont Pelée, was really a crater lake. Heilprin concludes that the greater part of the water of this shallow pool after the first eruption was steamed off by the heated ejecta that were thrown into it. These are in part angular blocks of andesite, trachyte and diorite, with here and there scattered boulders of large size and composite character, representing the ancient stock of the volcano. This conclusion is a significant one, contrasted with the supposition of Drs. Flett and Anderson, who were sent out by the Royal Society, that a great

column of molten lava rose to the orifice and exploded. In this place Professor Heilprin apparently holds to the view that the materials ejected are comminuted country rock—an opinion heartily endorsed by the present reviewer. The crater is described as occupying the entire basin of the ancient Étang Sec, and this lay in a gorge distinct from that other head-water tributary of the Rivière Blanche, known as the Rivière Claire, where in 1851 a number of vents opened and ejected ashes. While this is doubtless true, it is probable that all these gorges are now united in the present great amphitheater filled by the new cone. Professor Heilprin recognizes the difficulty attending all surmises as to the exact location of the opening whence came the destroying blast; but he believes it most probable 'that the blast issued from the basal floor of the basin, rather than from a constructing cone.' He states that the lower discharges were always more violent and paroxysmal than those from the upper cone, and that they carried the heaviest charges of ash, sometimes to heights of two miles or more. In this there is no suggestion of a vent low down on the mountain slope, but merely the difference between the base and the summit of the new cone. Violent discharge from the side of the cone has also been noted by Lacroix, and this characteristic is a common one; the ancient crater of Soufrière in St. Vincent, as described in the chronicles of 1812, had a central cone and lakes at the side. The present crater in St. Vincent, when visited by the reviewer on May 31, showed most violent activity on the southeast side of the great cauldron, rather than in its middle. In the center beneath the boiling waters of the pool, there is probably to-day a cone similar to the one on Mont Pelée, representing the direct back-fall of the heaviest materials ejected vertically.

In discussing the volcanic relations of the Caribbean basin, Professor Heilprin follows Suess in the belief that the Caribbean Sea is comparable with the Mediterranean as an area of depression, surrounded by mountain ridges, the islands of the Antilles being in the main merely disrupted parts of a once 'continuous land area.' It is hard to follow him confidently when he states that the volcanic activity of these islands belongs 'to a period of no great geological activity—perhaps nowhere more ancient than the middle tertiary.' Hill has shown clearly that in miocene time there was the most notable orogenic movement in tertiary Caribbean history, and active vulcanism dates probably from the beginning of the eocene. The Suess theory that the Caribbean-Gulf basins are great subsiding areas which 'break, squeeze and press, and as a resultant lands are folded up and volcanic discharges brought to the surface,' is simple and attractive, but in no way proved. The same may be said of the philosophy which links volcanic eruptions on one side of an ocean, with earthquakes on the other that chance to be contemporaneous, or nearly so. It is strange that a colossal seismic disturbance that would bring about correlated phenomena in Guatemala, St. Vincent and Martinique should have no effect whatever on other vents along the same line of fissures as those of these islands. It seems safer to regard such large generalization with a distrustful eye, and to keep in mind earth scale when we speak of 'the outer crust or shell of the globe as resting on a molten interior.' The horizontal scale of the Caribbean Sea, in proportion to the vertical relief of the tiny volcanic blisters, is so enormous that it seems safe to treat the little volcanic fissures very superficially. We know nothing of the earth's 'interior,' nor even of a 'shell.' All that geologists know of rocks can hardly be called a film, in proportion to the great unknown globe within. While the author's view on these points may be open to question, we entirely agree with his opinion that there is no evidence of any recent decrease of volcanic activity in the Caribbean region, and he might well go further and question whether there has been diminution since prehistoric times; human time, like human measure of space, is inadequate for determining such a question.

In the discussion of the phenomena, presumably the statement on page 272 that the 'sweep of the blast could not have been less than from one to two miles an hour' is a

misprint. The statement that 'pumice and bombs prove the existence of a molten magma which rises well into the throat of the volcano,' may be questioned, for ancient glassy tuffs and pumice are abundant in the old agglomerates of Martinique, and the bombs are old rocks merely melted on the surface. The estimate of amount of ash sediment discharged, based in part on Russell's expression of the cubical content of a steam cloud, is full of fallacy. The argument is as follows: If a single cloud has a capacity of four billion cubic feet, is charged with one per cent. of solid matter, and is regularly replaced every five minutes by another cloud of the same size, the total discharge of solid matter per day is 11,520,000,000 cubic feet. This is one and a half times the discharge of the Mississippi River per year, and on this basis the discharge of Pelée is greater than that of all the rivers of the world combined, for the same period of time. This argument is concluded with the question, 'what becomes of the void that is being formed in the interior?' The defect in this sort of reasoning lies in the assumption that a primary eruption is continuous for days or even hours. There have been a few moments of violent outburst at certain intervals, which were undoubtedly explosions from great depth, and may be called primary eruption. Secondary explosion continues for weeks in the intervals, and is occasioned by the contact of superficial water and hot deposits. Obviously such explosions are only working over the same material, yet they occasion tremendous puffs that rise many thousand feet, and perfectly simulate deep-seated processes. Professor Heilprin has failed to discriminate primary and secondary eruption when he talks of Mt. Pelée being 'in a condition of forceful activity for upwards of 200 days.' The reviewer questions whether the volcano has been forcefully active from great depths for that many minutes. There have been eight or nine considerable eruptions, and probably none of these lasted more than five or ten minutes. There is no probability of a void in the interior; there is a fissure system, and with the removal of material from the walls, there is probably collapse that is compensated so gradually by subsidence over a wide area, that it makes no appreciable effect even on the height of shore lines.

As a whole the book is a good exposition in popular style of the main facts connected with the Caribbean eruptions of 1902. There are not sufficient maps to make all geographical matters clear, and there is a lack of diagrammatic illustration, much needed to make intelligible certain explanatory or theoretical statements. The scientific results of Professor Heilprin's research would be more easily grasped if they were tabulated; he will doubtless compile tables in more technical forms of publication. His summary of the phenomena, and the description of events in August which came under his immediate observation, will stand as records of permanent value to vulcanology. T. A. J., JR.

SCIENTIFIC JOURNALS AND ARTICLES.

THE opening (January) number of Volume 4 of the *Transactions* of the American Mathematical Society contains the following papers: 'Orthocentric properties of the plane n-line,' by Frank Morley; 'Definitions of a field by independent postulates,' by L. E. Dickson; 'Definitions of a linear associative algebra by independent postulates,' by L. E. Dickson; 'Two definitions of a commutative group by sets of independent postulates,' by E. V. Huntington; 'Definitions of a field (Körper) by sets of independent postulates,' by E. V. Huntington; 'On the invariants of differential forms of degree higher than two,' by C. N. Haskins; 'Über die Reducibilität der Gruppen linearer homogener Substitutionen,' by Alfred Loewy; 'The quartic curve as related to conics,' by A. B. Coble; 'The cogredient and digredient theories of multiple binary forms,' by Edward Kasner; 'On the envelopes of the axes of a system of conics passing through three points,' by R. E. Allardice; 'A Jordan curve of positive area,' by W. F. Osgood.

THE December number of the *Bulletin* of the American Mathematical Society contains: 'Concerning the commutator subgroups of groups whose orders are powers of primes,' by W. B. Fite; 'Note on irregular determinants,' by L. I. Hewes; 'Note on the projec-

tions of the absolute acceleration in relative motion,' by G. O. James; 'Infinitesimal deformation of the skew helicoid,' by L. P. Eisenhart; 'On integrability by quadratures,' by Saul Epsteen; 'The centenary of the birth of Abel,' by E. B. Wilson; 'The English and French translation of Hilbert's Grundlagen der Geometrie,' by E. R. Hedrick; 'Dickson's linear groups,' by G. A. Miller; 'Buckingham's Thermodynamics,' by E. H. Hall; 'Notes'; 'New publications.' The January *Bulletin* contains: 'The October meeting of the American Mathematical Society,' by F. N. Cole; 'Series whose product is absolutely convergent,' by Florian Cajori; 'Three sets of generational relations defining the abstract group of order 504,' by L. E. Dickson; 'Generational relations defining the abstract simple group of order 660,' by L. E. Dickson; 'The Carlsbad meeting of the Deutsche Mathematiker-Vereinigung, September, 1902,' by C. M. Mason; 'Shorter notices'; 'Notes'; 'New publications.' The February *Bulletin* contains: 'On the transformation of the boundary in the case of conformal mapping,' by W. F. Osgood; 'On the quintic scroll having three double conics,' by Virgil Snyder; 'Surfaces referred to their lines of length zero,' by L. P. Eisenhart; 'Supplementary note on the calculus of variations,' by E. R. Hedrick; 'The synthetic treatment of conics at the present time,' by E. B. Wilson; 'Brown's lunar theory,' by F. R. Moulton; 'The doctrine of infinity,' by E. R. Hedrick; 'Some recent German text-books in geometry,' by P. F. Smith; 'Notes'; 'New publications.'

Bird Lore for January–February has an illustrated paper on 'The Mound-building Birds of Australia,' by A. J. Campbell; an article on 'Making Bird Friends,' by Laurence J. Webster, and one on 'The Return of the Nuthatch,' by E. M. Mead; the 'Christmas Bird Census,' taken in various parts of the United States, and a second series of portraits of members of *Bird Lore's* Advisory Council. The article on 'How to Study Birds,' by Frank M. Chapman, treats of 'The Nesting Season,' and Abbott M. Thayer protests against the use of 'Mounted Birds in Illustration,' a subject which has another side to it, shown in the editor's reply.

The American Museum Journal for February contains a few announcements of material received in various departments, and illustrations of the new ptarmigan groups. The important part of the number is the supplement, by William Beutenmiller, devoted to 'The Hawk-moths of the Vicinity of New York.' Besides a key and descriptions there is an illustration of each species, so that the merest tyro should be able, with the aid of this little hand-book, to identify all. This makes the tenth of the valuable 'Guide Leaflets' issued by the American Museum.

SOCIETIES AND ACADEMIES.

BIOLOGICAL SOCIETY OF WASHINGTON.

THE 367th meeting was held Saturday, February 21.

D. E. Salmon spoke of 'The Recent Outbreak of the Foot-and-Mouth Disease in New England.' He said that the effects of an outbreak of this kind, if not promptly checked, would be so disastrous financially that the Bureau of Animal Industry was always careful to ascertain that the malady reported was really foot-and-mouth disease; having ascertained the facts in the present case, every means was promptly taken to stamp it out. Dr. Salmon described the symptoms of the disease, saying that it was so extremely contagious, that it was readily carried from barn to barn by men, dogs and even pigeons, and once introduced into a herd, every member was pretty sure to be afflicted. While the distemper did not, in very many cases, cause death, it was extremely painful to the cattle afflicted, destroyed their value as beef for many months, and dried up the milk at once. Foreign governments prohibited the importation of cattle from afflicted districts, and as the United States exported annually 400,000 cattle and 100,000 sheep, the immediate effect of an outbreak in our western cattle regions could readily be seen. Furthermore, if there were no cattle for exportation some steamship lines would be compelled to withdraw their vessels. The only practical way to check the

disease was to kill the cattle affected, and in New England something like 2,500 head had been killed and their owners reimbursed by the government. The speaker described the methods adopted to kill the cattle and disinfect the barns, and the great precaution taken by the inspectors not to spread the plague.

H. J. Webber discussed 'Egyptian Cotton in the United States,' saying that as this variety possessed many special advantages, we imported annually $10,000,000 worth. Experiments had been made with a view to raising this cotton in the United States, but at first sufficient care was not taken to ascertain the best soil and climatic conditions. In some localities where the plant grew well, it grew too rankly and furnished but little cotton. The speaker then described the methods adopted by the Bureau of Plant Industry to produce plants adapted to conditions found here, and said that the outlook was very promising. Mr. Webber illustrated his remarks by many samples of various grades of cotton and by photographs.

W. E. Safford gave an account of 'The Fauna of the Island of Guam,' describing in some detail the few mammals and the principal birds, fishes and insects.

F. A. LUCAS.

THE CHEMICAL SOCIETY OF WASHINGTON.

AT a special meeting of the Society on February 5, Dr. M. Gomberg read a paper on 'Tri-ethyl-methyl.' The speaker gave a historical review of the work already published, and also of some work which is soon to appear in print. The subjects taken up were: (1) The preparation and constitution of triphenylmethyl peroxide. (2) The preparation of the triphenylmethyl, and also of its ether and ester derivations, the constitution of which is explained on the assumption of tetravalent oxygen. (3) The preparation and the reactions of triphenyliodomethane. (4) The salt-like character of the triphenylhalogen methanes from the chemical, and from the physico-chemical standpoint. (5) The condensation of triphenylmethyl to hexaphenylethane by means of different reagents. (6) Experimental evidence that metals split off only halogen from triphenylchlormethane. Apparatus and specimens of the various preparations were exhibited.

J. S. BURD,
Secretary.

U. S. DEPARTMENT OF AGRICULTURE,
WASHINGTON, D. C.

THE TORREY BOTANICAL CLUB.

THE club held its regular meeting on January 28, at the New York Botanical Garden. In the absence of president and vice-presidents Dr. Britton was called to the chair.

The leading paper was by Mr. R. S. Williams, on 'Some Economic Plants of Bolivia.' He mentioned the great diversity of climatic conditions in Bolivia, and stated that at the higher altitudes frosts occur during ten months of the year. Pasture grasses abound at these elevations. Among the chief crops for the higher agricultural lands are barley, wheat, potatoes and quinoa—the edible seed of a species of the Chenopodiaceæ. Many varieties of corn are cultivated up to an altitude of 5,000 to 6,000 feet, and beans of many kinds are also grown. Rice is the principal grain crop of the lower tropical regions. Sugar-cane grows up to 4,000 feet, and there are large fields of it everywhere. It is crushed by passing the stalks back and forth between rollers turned by oxen. The fruits of the lower country are lemons, oranges, bananas, papayas, cherrimoyas, granadillos and a number of others. A species of sorrel, *Oxalis tuberosa,* is largely cultivated. The tubers are eaten as a vegetable. Tomatoes are raised, but they are poor and small. Peppers are in great variety and are much used. Coffee is grown up to 5,000 feet elevation. A fine quality is produced, but distance from the seaboard prevents its export. There are no wild fruits or nuts of value in the regions visited.

The paper was discussed by Dr. Britton, Professor Selby and others.

Mr. F. S. Earle spoke briefly on 'The Fungus Flora of Jamaica.' Jamaican fungi have been mentioned by various writers, beginning with Patrick Browne in 1755, but the total number of species so far reported from the island is less than one hundred. About five hundred members of fungi were collected

by the speaker during his recent visit to Jamaica. The collection has not as yet been sufficiently studied to estimate the number of species represented in it. Nearly half of the entire number belong to the Polyporaceæ, about a hundred to the Agaricaceæ, thirty to the Thelephoraceæ, but only three to the Hydnaceæ. Of the Ascomycetes fully half belong to the Xylariaceæ.

As a rule, fungi are more abundant at the lower elevations and on the drier parts of the island. In the moist mountain woods, where the conditions are most favorable to the growth of ferns, fungi are comparatively rare.

Mr. Nash exhibited a living flowering specimen of an undescribed species of *Pitcairnia* collected by Dr. Britton on St. Kitts, West Indies. Among its more prominent characters are the absence of spines and the conspicuous whitening of the under side of the leaves. Dr. Britton described the finding of this plant at the summit of Mt. Misery on the rim of an extinct crater. It was growing in a deep carpet of moss and was associated with other bromeliads, including *Pitcairnia alata*, which is a spiny species, and an undescribed *Tillandsia*.

Dr. Howe was called to the chair and Dr. Britton presented resolutions on the recent death of Dr. Timothy F. Allen.

MEETING OF FEBRUARY 10.

In the absence of the president, Dr. Lighthipe was called to the chair.

The paper of the evening was by Mr. Eugene Smith, entitled 'Remarks on Aquatic Plants.' The speaker exhibited a series of specimens of marsh and aquatic plants. The distinction between the two is not sharply drawn, but true aquatics pass their entire life under water or at most only produce their flowers and fruit at the surface. The flowers of true aquatics are never showy. Marsh and aquatic vegetation contains elements that are very diverse from a systematic point of view, including representatives from the lowest to the highest families of plants. The algæ are exclusively aquatic and constitute the greater part of the under-water vegetation. The bryophytes are represented by numerous species, a few of which are true aquatics. The pteridophytes have a few aquatic and semi-aquatic members. Many families of flowering plants include aquatic species. With water plants having both submerged and floating leaves there is usually a marked difference in form between the two. The tissues of aquatics are usually soft and flaccid, since these plants, being supported by the water, do not need to develop woody tissues. The study of aquatic plants has been much neglected. The waters of tropical regions in particular afford almost a new field for exploration and study.

An interesting discussion followed the reading of the paper, many of the members present taking part in it.

F. S. Earle,
Recording Secretary.

DISCUSSION AND CORRESPONDENCE.

THE ST. LOUIS MEETING.

To the Editor of Science: Your recent editorial on the importance of beginning early to make plans for the St. Louis meeting of the American Association for the Advancement of Science and the affiliated scientific societies prompts me to make a few suggestions and to raise one or two questions.

As to the accommodations necessary for a comfortable and therefore profitable sectional meeting there should be for each section of the association: (*a*) a meeting room, (*b*) a lobby or conversation room, and, if possible, (*c*) a coat and toilet room; the three rooms to be close together. It is evident, enough from our experience at various meetings, either that these three elements of comfort are not considered essential by the local committees, or that if they are so considered they can not be secured for all the sections; yet it may be fairly contended that meetings as important as are the gatherings of the sections deserve the reasonably comfortable accommodations above suggested. Further specifications may be made as follows:

Meeting Room.—The table for the presiding officer and the secretary, the platform, blackboard, etc., for the speaker, and the seats for the audience should form a triangle. This arrangement makes it possible for the

occupants of each corner of the triangle to see those of both the other corners. Any other arrangement is likely to involve the presiding officer in much difficulty if he attempts to see the illustrations shown by the speaker, and to impose upon the speaker the discourtesy of turning his back upon the presiding officer. The presiding officer and the secretary should have an open pathway from their table to a neighboring door; a page ready to attend these officers and familiar with the locality of the meeting should be furnished by the local committee. A platform for the speaker, raised somewhat above the floor, should be provided in rooms not thus furnished. Blackboard and pointer, racks, clips and thumbtacks, lantern and screen should of course be in readiness (perhaps some sections may not need the lantern), though it not infrequently happens that some of these necessary luxuries are wanting at the last minute. The auditors should enter by a door or doors at or near the back of the room; and they should not have bright windows in front of them. The room should be large enough to prevent crowding. One might think that ventilation would be arranged beforehand as a matter of course; yet it is a common experience to have to resort to the windows after the meeting room has become suffocatingly uncomfortable, no one being charged with the duty of supplying fresh air; and the windows usually refuse to open at the top, there evidently having been no preparation for so unexpected a use of the upper sash. The air in the sectional meeting room that I frequented this winter in Washington was almost continuously so bad as to be injurious to health. Electric ventilators are of much service in this connection; they can usually be installed temporarily at moderate expense.

Lobby and Coat Rooms.—Emphasis is always and properly laid on the opportunity that the association meetings furnish for renewing and extending one's acquaintance with his associates. This is so important a matter that formal provision should always be made for it. A single room is, therefore, not enough for a good sectional meeting; there should always be a separate lobby or conversation room, near enough the meeting room to be immediately accessible from it, yet not so near that lively conversation in the lobby shall annoy either the speaker or the auditors in the meeting room. Two or three seats at a writing table should be provided here. Now that meetings are to be in the winter, a coat room will be a great convenience, to say the least.

It is very likely that many local committees will find it difficult to provide the three desired rooms for each section; and this elaborate provision will often be impossible if various scientific societies hold meetings at the same time and place with, but independent of, the sectional meetings. The question then arises: Is it worth while to endure continuously uncomfortable conditions of sectional meetings in order to secure the intermittent advantages of occasional general sessions? My own feeling is that a really well-managed meeting of a national scientific society, such as the Geological Society of America, held independent of the association, gives more profit and pleasure to the attending members than they are likely to secure when their meeting is held in conjunction with that of the association. In the latter case it is almost impossible to provide the accommodations that a national society really deserves, and the discomforts of insufficient accommodations seem to me to outweigh whatever advantages come from a general scientific gathering. In short, if the alternative were presented to one of the national scientific societies of being limited to one meeting room when combining with the association, and of having separate meeting and conversation rooms when acting independently, I should vote for the latter, so high a value do I place on the informal part of a scientific gathering. But if really good accommodations can be provided for the sections and the national societies when all meet together, then let us gather in force and secure whatever results may follow from meetings of large enrollment.

There are certain other suggestions that might be presented to the local committees.

Free lunches are a burden on the local committee that no visiting member should wish to impose; scattered lunches interfere greatly with the sociability of the meeting; distant lunches take up too much time. A light table d'hôte lunch should, therefore, be provided at a moderate price in a good-sized and well-ventilated room near the place of meeting, every day while the sessions last. Separate small lunch tables are preferable to a single long table; service is much simplified by having the dishes on a table at one end of the room, where each member may quickly help himself and then withdraw to enjoy the lunch with a group of friends. The less the formality and the greater the freedom of movement, the better for the real enjoyment of the noon hour.

Formal dinners, such as the affiliated societies not infrequently hold and at which one has to sit in one place for three or four hours, are likely to be tiresome to one's neighbors. Informal smokers, with a light supper served from a side table and plenty of little tables at which groups may easily form and break up, afford much better opportunity for meeting and chatting with old and new friends. Besides, the dinners seem necessarily to involve the conventionality of after-dinner speaking, in which one is in danger of grieving his friends with wide-of-the-mark efforts at humor. The smokers are not yet habitually given over to that form of festivity.

Finally, a few remarks as to general sessions. Most of them are tedious. There seems to be a supposed necessity that the association shall be welcomed by some representative local authority, and that some officer shall respond to this address in a preliminary general session; but it would be interesting to try the experiment of meeting once without these formalities, in order to see if science were any the less advanced thereby. This unconventional plan would at any rate have the advantage of allowing the council to arrange three or four, instead of only two, periods in which the vice-presidential addresses could be distributed, thus making it possible for them to be heard by a much larger number of members than is now the case; and this is certainly desirable, for many of the addresses are of broad interest and should attract large audiences. As to the brief general sessions every morning of convocation week, they are often very thinly attended; it must be but a small pleasure to the president and the secretary of the association to officiate at these listless gatherings. Indeed the sectional lists of papers are now so long that time can ill be spared for daily general sessions. The announcements that have been customarily made at the general sessions—for example, the hour and place of an excursion, or the names of new members—can be much more effectively made at the sectional meetings or in the daily programs. The final general session, at which the officers for the ensuing year and the place of the next meeting are voted upon or announced (whichever practice may now be followed) and in which cut-and-dried votes of thanks are passed in perfunctory fashion, have become lifeless affairs, thanks to the efficient work of the council. Few members would be afflicted if even this final general session were replaced by printed announcements. The two general sessions in the evening, to hear the retiring president's address and the general scientific lecture, are on the other hand of real value in advancing science, and should be maintained.

The intention of all these suggestions is to make it possible for those who attend the meetings of the association to spend their time most effectively and comfortably. Conventional formalities, bad air and distracting gymnastic efforts at opening windows, insufficient room and time for social intercourse are unnecessary hindrances to the best enjoyment of convocation week; and there is no sufficient reason why many or all of these hindrances should not be removed.

W. M. Davis.

Cambridge, Mass.,
February 25, 1903.

THE POLICY OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

I have attended many meetings of the American Association for the Advancement of Science and have watched with great interest the progress that has been made—espe-

cially during the past three years. An able standing committee looks after its policy, and notwithstanding the large increase of members, this policy is to advise reducing the size and value of the proceedings by printing only the addresses of the president and vice-presidents, with list of officers and members and a few other items, to the end that more money may be accumulated, that it will earn more interest and enable the society to give a very few persons a small portion of the cost of engaging in some research.

Not many months ago SCIENCE contained a large number of interesting communications by way of gentle reminders as to how the trustees of the Carnegie Institution could best use the funds soon to be at their disposal. This was a kind and thoughtful service and no doubt highly appreciated by the trustees. Among these gentle hints was named the pressing need of means for publishing worthy articles such as might not be published by any of the numerous journals or might not find a place in the proceedings of any of the learned societies.

When the *American Naturalist* was established in 1868, I am sure the editors were not troubled to find room for all worthy articles in the entire field of botany and zoology, including some that bordered on geography and geology. Workers in these broad fields were comparatively few and far between. In these days, universities and colleges have established many courses attracting a large increase in students, requiring numbers of teachers, some of whom devote a portion of their time to original work. The U. S. Department of Agriculture employs many; the state experiment stations many; bureaus of geology, ethnology, and meteorology and others are growing rapidly.

I dare not attempt to name the journals and transactions that are issued from time to time.

It is getting to be the plan for most universities to publish each from one to four or more periodicals devoted to as many special departments of learning, soon to find that the members of the faculty, their fellows and advanced students, without any outside help, write enough papers or nearly enough to fill all the pages of these journals.

The programs of the meetings of the American Association are filled with valuable papers, at least if they are not valuable it is the fault of the committees whose duty it is to inspect the list before reading.

One of the reasons sometimes advanced for omitting to print these papers in the *Proceedings* of the association is that any papers that are worthy will be sought by the editors of some scientific journals. We have now reached a period when this is far from true. The value of a paper can not be measured by its popularity.

At the meetings of the American Association we hear papers read and we are interested in them—some we can not hear, owing to numerous conflicts of programs. For myself I make a memorandum of those I hope some day to be able to read, but by some hook or crook I seldom get them.

In days past I have often looked in the *Proceedings* for some article important to me, to find an abstract of a few lines only, or rarely a reference to some publication where it has been printed.

I feel confident that if we had a full canvass, a large majority of the members would be glad to see these papers printed in the proceedings of the American Association. For printing papers, it is true we have SCIENCE, a magnificent publication, but we see even in this there is not room for all.

Every few months our attention is called to some new means of support for worthy investigators—and liberal support. I need not enumerate them. The fees that the American Association is able to pay for research are very trifling. Why not use all the funds that henceforth accumulate, up to a certain specified amount, to defray the expenses of printing and *illustrating* first-class reports? What better use could be made of the money?

If I am not mistaken, one reason for organizing some of the 'affiliated' societies was that the members could publish the papers read at their meetings. I have known a number of instances in which itinerant societies for worthy purposes have economized to save a

fund, the interest of which might serve the means of partial support, but through some oversight a large portion of the original fund was dissipated. I think our fund is as large as it should be, perhaps larger. I shall be surprised if some of the conservative and substantial fellows and members of the American Association for the Advancement of Science do not come out in support of the views here expressed. W. J. Beal.

Agricultural College, Mich.,
February 20, 1903.

ABUNDANT HONORARY DEGREES.

To the Editor of Science: In *Bulletin* No. 12, Volume III., issued by the University of Missouri, is a review of the manifold achievements of the university, especially those of benefit to the state of Missouri.

Along with other items appears the statement that 2,869 degrees have been conferred 'for work done.' 'Of honorary degrees 152 have been conferred.' Figured into percentage the number of honorary degrees becomes nearly 5.3 per cent., or more than one honorary degree for every twenty regular degrees. I think Missouri is to be congratulated upon the extraordinary proportion of eminent men connected with her university, and I can not help wondering why I am so ignorant as never to have heard of the names even of many of those of the honorary 5.3 per cent. class. I wonder less, perhaps, than might be expected because the custom of bestowing honorary degrees on unknown people is almost universal among American colleges and universities.

Is it not time to raise a universal protest against this habitual debasement of the highest academic honor? All of our universities sin grievously in this respect, and give honorary degrees to soldiers, politicians and many other classes of worthy people who can not present the slightest claim to scholarly eminence.

When we consider how much more many a little-known scholar does for the world than many celebrated soldiers and politicians, it seems proper that the practice should be reversed. I venture, therefore, to propose: (1) That we all strive to restrict the bestowal of honorary degrees exclusively to scholars and investigators, who alone have any claim to them, and (2) that we petition the national government to make all eminent physicists honorary generals, all eminent chemists honorary admirals, all eminent naturalists honorary governors, and all members of the National Academy honorary senators.

C. S. M.

Boston, February 23, 1903.

SHORTER ARTICLES.

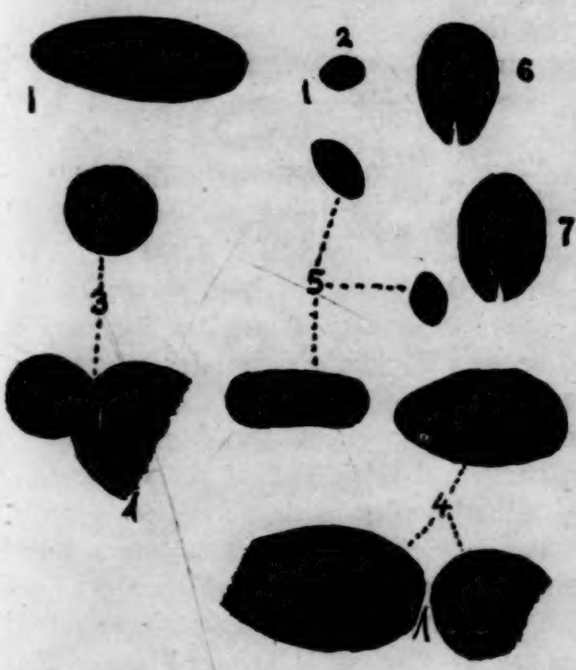
THE SACRAL SPOT IN MAYA INDIANS.

In 1901, while at Tekax, Yucatan, making measurement of the Mayas of that district, the parish priest told me that it was commonly believed that every pure-blood Maya Indian had a blue or purple spot upon his back, in the sacral region. He said that this spot was called *uits*, 'bread,' and that it was an insult to a Maya to make reference to his *uits*. To satisfy the curiosity of the priest, and my own, I examined a boy of ten years and two men, all of pure Maya blood. No one of the three presented any trace of a sacral spot, and I concluded that the common belief, if it had any basis, must relate to an infantile spot such as has long been known to occur in the Japanese, Eskimo, etc. Having no opportunity then to examine Maya babies, I determined to watch for the sacral spot among the infants of such tribes as I might later visit.

In my last journey to Mexico, just ended, I expected to see babies among six Indian populations—Aztecs, Zapotecs, Tzotzils, Tzendals, Chols and Mayas. From changes in my plan I really came into contact with the Aztecs and Mayas only. Aztec friends in whom I have confidence, in the states of Pueblo, Mexico and Tlaxcala, agreed that Aztec babies do *not* have a sacral spot; I made no personal examination.

In the town of Palenque, Chiapas, I examined all the *little* babies of the town—not a heavy labor, as the town is small. The people here call themselves Mayas, but claim to be closely related to the Chols. Probably the population is a mixture of the two peoples, who are closely related in language, and

probably in blood. To my surprise, I found the spot in every one of the seven babies of pure Indian blood. It seems, however, to be far more evanescent among the Mayas than among the Japanese and other populations, being rarely found in individuals of more than ten months of age. Three babies, less than ten months in age, but of mestizo (mixed-blood) parentage, showed no trace of the spot. The spot is variable in size, shape and position, but it is always in the sacral region; in color it is blue or a bluish-purple; it gradually disappears and two or three of the cases seem to show an original single spot broken up into separate blotches which lose distinctness.



The sizes and shapes of the spots observed are accurately shown in the accompanying cut, reduced to one half the diameter. The notes made regarding each are here presented:

1. Boy; eight months. Spot well marked; dark purple; median, three inches above the anal fold. An older brother, two years old, showed no sign of the spot, but his mother says he was equally well marked at birth.

2. Girl; one year. Spot well defined; just to the right of the upper end of the fold.

3. Girl; three months. Two faint and badly defined spots just to the left of the upper end of the anal fold; a darker and better defined spot above.

4. Boy; two months. Two faint and badly defined spots, one on either side of the anal fold; a third, darker and better defined, above.

5. Boy; ten months. Only the lower of three spots is fairly defined, and it is faint, like a disappearing bruise; the other two are fainter. The three look like the separated parts of a spot which is disappearing. The group is median and located a little above the anal fold.

6, 7. Boys; twins of two months. Spots are pale blue but well defined; they are almost identical in form, size, color and position. They just overlap the upper end of the anal fold.

FREDERICK STARR.

February 6, 1903.

THE EGGS OF THE EASTERN ATLANTIC HAG-FISH, MYXINE LIMOSA *Gir.*

EGGS of a hag-fish from the Newfoundland banks were described by the present writer in 1900 (*Mem. N. Y. Acad. Sci.,* Vol. II., pp. 31–43) from specimens in the Verrill collection, Yale University. They were then looked upon as belonging to the common North Atlantic *Myxine glutinosa* Linn. Since that time, however, the eggs of five other species of myxinoids have been examined, and a fairly definite knowledge is at hand in the matter of the degree of variation in these eggs within specific limits. It follows from these studies that the differences between the eggs of *M. glutinosa* as described by Jensen and those of the Newfoundland form are too great (*op. cit.,* pp. 35, 42) to warrant the eggs of both types to be included under *Myxine glutinosa.* Accordingly I have come to the conclusion that we must consider the American specimens as probably representing *Myxine limosa* Girard, the common hag-fish of Maine. I would also note that a study of variation among myxinoids has recently led me to conclude with Mr. Garman that *Myxine limosa* is to be accepted, not as a variety of *M. glutinosa,* but as a valid species.

BASHFORD DEAN.

ORIGIN OF NAME MONOTREMES.

I HAVE been unable to find any reference to the early use of the now familiar name Monotremes, and the information may be of

use to some of your readers. I, therefore, give exact reference.

At the session in 'Thermidor, an 11 de la Republique' (1803), 'E. Geoffroy' [Saint Hillaire] presented an 'Extrait des observations anatomiques de M. Home, sur l'echidné,' which was published in the *Bulletin des Sciences de la Société Philomathique* (Tome III., p. 225–227—misprinted 125–127—pl. 14–16). In this communication Geoffroy remarks that '*Ornithorhincus*' (*Ornithorhynchus*) and *Echidna*, though closely related, are generically distinct, but should be united in the same order ('*ordre*'). He reasons as follows:

"Mais, cependant, comme il est démontré, par la dissertation de M. Home, que ces deux genres s'appartiennent par un assez grand nombre de rapports, je les réunis dans le même ordre, sous le nom Monotrémes, avec le caractère indicateur suivant: *Doigts onguiculés; point de véritables dents; un cloaque commun, versant à l'extérieur par une seule issue.*"

In this article was also published the name *Echidna setosa*, as is well known.

Rafinesque, in 1815, in the 'Analyse de la Nature' (p. 57), gave the Latin form Monotremia to the word, adopting it for his '16 famille' of mammals. Theo. Gill.

Cosmos Club.

CURRENT NOTES ON PHYSIOGRAPHY.

OVERTHRUST MOUNTAINS OF NORTHERN MONTANA.

The physiographic features that are associated with various stages of dissection of uplifted, folded or faulted structures are coming to be fairly well known; but the features resulting from the dissection of overthrust masses have as yet hardly gained recognition in systematic physiography. Hence the importance that attaches to certain passages in an account by Willis of the 'Stratigraphy and Structure, Lewis and Livingston ranges, Montana' (*Bull. Geol. Soc. Amer.*, XIII., 1902, 305–352), where a great overthrust has carried a heavy and resistant series of nearly horizontal Algonkian strata more than seven miles eastward over the previously warped Cretaceous strata of the plains. The overthrust mass is now greatly denuded; castellated outliers and promontories stand forward between large embayments, and the embayments are drained eastward over the plains as if the original drainage of the overthrust mass (presumably westward) had been destroyed by the retrogression of the overthrust escarpment. Before the overthrust took place, the relatively weak strata of the plains had been worn down to a peneplain; and it is believed that the Algonkian strata further west had at the same time been reduced to moderate relief. The general uplift associated with the overthrust exposed the plains to dissection, but remnants of their peneplain phase are still well preserved. The more active uplift of the overthrust raised the Algonkian strata to mountain height and allowed their deep dissection, but back of the Front ranges the subdued forms of the earlier cycle are still more or less preserved in the mountainous uplands at heights of 7,500 feet, where the general profile is independent of structure. In the front ranges, where the mountains rise to heights of 9,000 and 10,000 feet, revived erosion, by both water and ice, has caused so great a dissection that no trace is to be seen of whatever subdued forms may have existed before uplift. Here the very general association of the higher summits with anticlinal belts, and of the intermediate longitudinal valley with a shallow synclinal belt, suggests corrugation at as late a date as that of the overthrust by which the general uplift was produced. Strong erosion by heavy valley glaciers is inferred in the Front ranges, where high-cliffed amphitheatres holding lake basins are characteristic features. One of the most notable peculiarities of the district is the location of the continental divide at the eastern base of the mountains, where a branch of Flathead river (Columbia system) rises at the very margin of the plains in the pass that is followed by the Great Northern Railroad.

THE OASES OF SOUF AND M'ZAB.

The dual character of geography is seldom better represented than in a study by Brunhes on 'Les oasis du Souf et du M'zab comme types d'établissements humains' (*La Géogr.*, V., 1902, 5–20, 175–195); that is, the physiographic environment and the organic response

both receive adequate attention. The oases of Souf are in a region of dunes, the 'erg' of the Algerian Sahara, separated from other settlements by several days' journey; everything here depends on removing the sand until the surface is lowered near enough the groundwater to enable date palms to grow; the heaped-up sand-ridges are as high as the tree tops, and as the wind blows the sand freely, continual labor is necessary to keep the gardens free from drifts. Yet under these highly adverse conditions, the oases contained in 1899 an industrious population of 22,620 souls, owning 6,979 camels, 24,510 sheep, 27,864 goats, and 192,152 palm trees. The Soafas have become expert trailers, for nothing can cross the sands without leaving a track. Theft is, therefore, less common here than elsewhere in the desert, for the thief can be so easily followed and discovered that thieving does not pay.

The oases of M'zab are in the stony desert or 'hammada' of a calcareous plateau. Here wells are dug in the valleys, and water is raised day and night for irrigation; rain is stored in reservoirs and led about in canals. The gardens have a luxurious vegetation; dates, figs and other fruits are produced. The population of seven M'zab towns in 1896 was 25,254 souls, owning 490 camels, 5,732 sheep, 3,837 goats, and 166,261 palms; besides these there are 5,795 semi-nomads with a much larger property in live stock. A fine palm is worth $100 or more; many of the Mozabites are rich. From both of these crowded populations emigrants go out northward to less arid lands. For both groups of oases Brunhes emphasizes an important fact: the people are not savages supplying their simple wants in a rudimentary manner; they are in an advanced stage of culture, their arts are highly elaborated, and are wonderfully adapted to making the best use of unfavorable surroundings, and their caravans maintain an active trade across the desert.

THE OTHER HALF OF GEOGRAPHY.

IF geography be concerned with the relation of the earth and its inhabitants, and if physiography be taken as the study of the physical environment of life, or the inorganic half of the total subject, it is apparent that there is no convenient name for the other half, in which the response of the inhabitants to their environment is considered. It is also true that there is to-day no well-organized and systematic treatment of the other half, although partial treatments abound, especially of the human elements of the subject, as in the works of Ratzel. There is good reason for thinking that the progress of geography in the century now opening will remedy these deficiencies; that the organic responses appropriate to many kinds of environments will be carefully collected and classified; that the attention of the geographical observer will be equally directed to both halves of his subject; and that geography will be greatly benefited thereby.

The preceding note gives a good example of a curious response to a desert environment, reaching even the moral sense. The rapid development of the study of physiography in our national surveys of the western semi-arid region, where the relation of structure and form is laid bare, exhibits a response of an intellectual kind to a climatic environment. Lugéon has suggested that it is not —as some have thought—an inherent spirit of independence in the Swiss that prompts them to maintain separate organizations in the minute village communities of the Alpine valleys, but that the physiographic opportunity for village settlements requires the development of many small communities instead of a few larger ones, and thus aids in the development of the spirit of independence. Fewkes has given an admirable example of the response of religion to environment in the 'Tusuyan ritual' (*Smithsonian Rep.*, 1895, 683–700). The systematic exploration and analysis of this phase of geography deserves much more attention than it has yet received. A fuller consideration of this aspect of the subject is given in two essays by the undersigned: 'Systematic Geography' (*Proc. Amer. Phil. Soc.*, XLI., 1902, 235–257) and 'The Progress of Geography in the Schools' (*Nat. Soc. Sci. Study Education*, I., Pt. II., 1902, 7–49).

W. M. DAVIS.

THE D. O. MILLS ASTRONOMICAL EXPEDITION.

THE D. O. Mills Astronomical Expedition from the Lick Observatory, University of California, sailed from San Francisco on February 28, to Valparaiso, Chili. The purpose of the expedition is to measure spectroscopically the line-of-sight velocities of the naked-eye stars in the Southern Hemisphere which are not visible at Mt. Hamilton. The observing station will be in the vicinity of Santiago, either on one of the low hills in the suburbs of the city, or along the line of the railway running from Santiago to Valparaiso. The apparatus consists principally of a 37½-inch reflecting telescope, Cassegrain form, to which is attached a powerful three-prism spectrograph. The instruments will be covered with a modern 30-foot steel dome. The expedition is in charge of Acting Astronomer William H. Wright, and he will be assisted by Mr. H. K. Palmer. Professor Wright has been a member of the Lick Observatory staff for the past six years, engaged in line-of-sight determinations with the Mills Spectrograph attached to the 36-inch equatorial. Mr. Palmer was for four years a fellow in the Lick Observatory. The government of Chili has taken note of the coming of the expedition, by admitting all the effects duty free, and by volunteering to further the purposes of the expedition in every possible way.

AMERICAN ORNITHOLOGISTS' UNION EXCURSION TO CALIFORNIA.

THE American Ornithologists' Union at its last session appointed a committee to consider the question of a spring meeting in California. The committee announces that it finds that the railroads are not only willing to grant very favorable rates, but that most satisfactory arrangements may be made with respect to stop-over privileges. In order that those who go may see as much as possible it is planned to make various stops in New Mexico, Arizona and southern California, including one at the Grand Canyon of the Colorado. It is planned to charter special Pullman cars for the outward journey so that the party may travel comfortably and as a unit, and to spend about ten days between Chicago and San Francisco. The plan is to leave Chicago May 3, to reach San Francisco on or about May 13, and to hold the special meeting May 15–16 in conjunction with the California members of the American Ornithologists' Union and the members of the Cooper Ornithological Club. The cost of the round trip is a single fare from the starting point to Chicago plus $50, and the tickets are good to July 15. Members of the union may invite friends interested in science to take part in the excursion. The committee consists of C. Hart Merriam, chairman; T. S. Palmer, and John H. Sage, secretary of the union, to whom communications should be addressed at Portland, Conn.

MINUTE IN REFERENCE TO THE DEATH OF PROFESSOR WILLIAM HARKNESS, U.S.N.

AT a meeting of the staff of the Naval Observatory and Nautical Almanac Office, held March 2, 1903, Captain C. M. Chester, Superintendent of the Naval Observatory, read the sad announcement of the death of Professor William Harkness, U.S.N., at Jersey City, N. J., at 3:37 P.M., February 28, 1903. Through a committee appointed at this meeting, the staff of the Naval Observatory and Nautical Almanac Office expresses its deep regret at the death of their colleague, and extends its heartfelt sympathy to his relatives in their bereavement.

Throughout all his connection with the Observatory, for 37 years previous to his retirement in 1899, a conscientious faithfulness even to the minutest details characterized the performance of all his duties. This adherence to duty was so rigidly carried out by him that he rarely gave himself the occasional relaxation so necessary to the recuperation of wearied energies, which might have added years of usefulness to his life.

The fruits of his laborious life as aid, professor of mathematics, U. S. Navy astronomical director of the observatory and director of the Nautical Almanac Office, are shown by voluminous scientific papers, whose publication has not been limited to the volumes

issued by the Observatory and the Nautical Almanac Office.

A large part of his energies was devoted through many years to service as a member of the Transit of Venus Commission.

During the past year it has been a special cause of regret to him that feebleness of body should compel him to forego participation in scientific work; meanwhile continually hoping soon to recover strength sufficiently to permit his return to Washington to complete various pieces of scientific work.

His energy and faithfulness should be emulated by all. His example should spur us on to greater faithfulness, activity and zeal in carrying on labors commenced by him and providentially committed to us to continue.

By unanimous vote it was resolved that the superintendent of the Naval Observatory be requested to place the above tribute to the memory of the late Professor William Harkness on the records of the Observatory, and to transmit a copy to the members of his family.

The foregoing minute having been read Mr. Thomas Harrison, the oldest associate of Professor Harkness at the observatory, made the following remarks, which by unanimous vote were appended to the minutes:

On this sad occasion, Mr. Chairman, I can not forbear to say a word, though it be only to regret my inability adequately to express the regard I have for many years entertained for the man whose memory we have met to honor.

It would be unbecoming in me to speak of his great and valuable labors at the Naval Observatory, the results of which have done so much to sustain the high reputation in this country and abroad that is now enjoyed by the Institution with which his name has been so long associated. These labors fall appropriately under the notice of those present who were his colaborers in the same field, and who can more readily than myself comprehend their magnitude and their value. But a personal reference may be allowed.

Professor Harkness came to the Observatory during the stirring events of 1862, when in the vigor of early manhood. He was assigned at once to the rank among scientists due to his varied attainments; and his life work then auspiciously begun, continued, ever widening in scope and influence, to the day of his death, which has just been announced.

The fact that I was permitted to enjoy his friendship will always be classed with the happy circumstances of my official life—a friendship which began 41 years ago, and continued to the moment he was stricken by the hand of death.

The often-quoted lines of Horace on the 'Just Man,' may well be applied to William Harkness.

March 2, 1903.

SCIENTIFIC NOTES AND NEWS.

A NOBEL Prize Committee has been organized in Great Britain with Lord Avebury as chairman.

MR. WILLIAM R. MERRIAM has resigned the directorship of the census.

M. LÉON LABBÉ, the surgeon and anatomist, has been elected a member of the Paris Academy of Sciences.

THE University of Glasgow will on April 21 confer the degree of LL.D. on Sir William Tennant Gairdner, emeritus professor of medicine in the University of Glasgow; Sir Norman Lockyer, F.R.S., director of the Solar Physics Observatory, South Kensington; Dr. Thomas Oliver, professor of physiology in the University of Durham and Mr. Philip Watts, F.R.S., director of naval construction, Admiralty, London.

THE University of Edinburgh will confer the LL.D. degree on Dr. Arthur Gambee, emeritus professor of physiology, Owen's College, Manchester; on Sir Norman M'Laurin, M.D., chancellor of the University of Sydney, and on Mr. Benjamin Peach, of the Scottish Geological Survey.

DR. WILLIAM R. BROOKS, director of Smith Observatory and professor of astronomy in Hobart College, has been awarded the Comet medal of the Astronomical Society of the Pacific for the discovery of his twenty-third

comet. This is the seventh award of the medal to Dr. Brooks.

Professor Edward S. Dana, of Yale University, whose ill health during the past three years has compelled him to give up the larger part of his class work, has gone to the Bermudas, where he will remain for several months.

Dr. J. T. Rothrock offered his resignation as commissioner of forestry of Pennsylvania, but later was induced by the governor to recall it.

Otto J. Klotz, astronomer of the Department of the Interior, Canada, leaves shortly for the Pacific, in charge of the longitude determinations along the British Pacific cable. By this work the earth will for the first time be girdled in longitude. The stations occupied will be Vancouver, Fanning, Suva, Norfolk and Southport, near Brisbane, Australia. Connection will also be made with New Zealand from Norfolk, where the cable bifurcates.

Professor L. M. Underwood, of Columbia University, spent part of January and February in Jamaica, studying the ferns of that island; this month he is making similar investigations in Cuba. Dr. N. L. Britton, director of the New York Botanical Garden, is also in Cuba.

The board of governors of the University Club, Philadelphia, tendered a reception and dinner to Dr. S. Weir Mitchell on Friday evening, February 27.

A complimentary dinner will be offered to Sir William White, F.R.S., lately director of naval construction to the British government, on March 26.

A souvenir number of the *Zeitschrift für Ohren-Heilkunde* was presented to Professor F. Bezold, known for his researches on the sense of hearing and its diseases, on the twenty-fifth anniversary of his professional career by his pupils and assistants.

Dr. E. Hitzig, director of the clinic for nervous diseases and the polyclinic at Halle, especially known for his experiments on cerebral localization, has resigned his professional duties on account of a progressive eye effection.

Captain Edward Appleton Haven, of Lynn, who has been selected as first officer of the steamer *America* on the Zeigler polar expedition is about to leave for Norway.

At the last meeting of the Zoological Society of London a motion was passed to the effect that the testimonials of Mr. W. L. Sclater, appointed by the council secretary *ad interim,* and those of Dr. Chalmers-Mitchell, the candidate for whom a minority of the council voted, should be printed and distributed to the fellows.

At the annual meeting of the British Institution of Mechanical Engineers on February 20, Mr. W. H. Maw resigned the chair to the newly elected president, Mr. J. Hartley Wicksteed. 520 new members have joined the institution during the year, and the membership is now nearly four thousand.

The Cambridge Philosophical Society on February 2 passed a resolution in memory of the late Sir George Gabriel Stokes, and adjourned as a mark of respect.

The British Virchow Memorial Committee has received £225 from ninety-seven subscribers.

A memorial tablet has been placed in the Anatomical Institute at Heidelberg to celebrate the hundredth anniversary of the birth of the anatomist, Friedrich Arnold.

The death is announced at Goerz, in Austria, of Ritter Karl von Scherzer, who took a leading part as scientific expert in the voyage of exploration around the world of the Austrian frigate *Novara* in the years 1857–1859.

Mr. Francis Cranmer Penrose, F.R.S., known for his work in astronomy, archeology and architecture, died on February 15 at the age of eighty-five years.

The death is also announced of M. Reboul, dean and honorary professor of chemistry at Marseilles.

The Carnegie Institution has granted the sum of $4,000 to the Lick Observatory for the present year, for the employment of assistants and computers. The director invites applications for these positions from well-equipped persons, especially from those who

are looking forward to an astronomical career.

THE College of Physicians of Philadelphia has secured pledges of $50,000 which makes available the $50,000 offered by Mr. Carnegie for a library building. The question has now arisen whether it would be better to enlarge the present building or to erect a new building on a different site.

As we have already stated the Congress of American Physicians and Surgeons will hold its sixth triennial session at Washington on May 12, 13 and 14. Sixteen national societies devoted to the medical sciences, including the American Physiological Society, the Association of American Anatomists and the American Association of Pathologists and Bacteriologists, join in the congress. The president is Dr. William W. Keen, of Philadelphia, who will deliver an address on the evening of May 12. The general sessions of the congress will be held on the afternoon of May 12 and 13.

THE Boston *Transcript* says a plan has been definitely approved for the holding of an International Congress of Arts and Sciences at the St. Louis Exposition. The congress is to convene on Monday, September 19, 1904, and continue until Friday, September 30. The congress will have before it the definite task of bringing out the unity of human knowledge, with a view to correlating the scattered theoretical and practical scientific work of our time. The addresses are to be prepared by the greatest authorities in each branch of knowledge. In each of the various subdivisions two papers will be presented—one on the history of that particular department of knowledge during the past one hundred years, and the other on the problems that now present themselves for solution in that field. It is planned to publish the proceedings, which, it is hoped, will be a permanent contribution to the cause of scholarship. An executive committee of representative scholars, Professors Simon Newcomb, of Washington, Hugo Münsterberg, of Harvard University, and Albion W. Small, of the University of Chicago, has been intrusted with the task of elaborating the details of this plan. It is expected that the three members of this committee will spend several months in Europe in the near future, conferring with the leading European scholars with a view to interesting them in the plan and securing their full cooperation.

A COMMITTEE has been organized for the International Botanical Congress which will meet in Vienna from June 12 to 18 in 1905. The honorary presidents are Professor Edouard Suess, president of the Imperial Academy of Sciences and the Austrian ministers of public instruction and of agriculture. The presidents, elected at the Paris congress of 1900, are Professors de Wettstein and Wiesner, of the University of Vienna. Correspondence in regard to the congress should be addressed to the secretary, Dr. A. Zahlbruckner, Bergring 7, Vienna.

THE National Dairy Association of Belgium has decided to hold an international congress at Brussels during the month of September, 1903, immediately after the eleventh Congress of Hygiene and Demography.

THE Indiana legislature has passed a bill which has been signed by the governor, the effect of which is to set aside under the control of Indiana University a tract of land of over 200 acres for an experimental farm. The land is covered by primitive forest and lies at the edge of the great cave region of the Ohio valley in which Wyandotte and Mammoth caves are situated. On this land are the only entrances to an extensive underground 'well' or brook which pours out its water into a narrow valley also on this farm. A large room 40 x 230 feet, easily accessible, is within 100 feet of the exit of the river. The farm is said to be ideally adapted for experimental work with cave animals. The land belonged to an alien without naturalized heirs, and on his death escheated to the state of Indiana. His heirs brought suit to recover it and the lower court confirmed the title to the state; an appeal is now pending in the supreme court.

THE University of California has leased for two years two square miles in Shasta county, California, where Professor John C. Merriam last summer secured valuable collections of fossils.

THE Sharon Biological Observatory, a sum-

mer school for teachers at Sharon, Mass., will experiment in forestry on a tract of 300 acres of woodland, which it purposes making into a model forest. Application has been made to the Bureau of Forestry for a working plan. The director of the school, Dr. Geo. W. Field, is an instructor in the Massachusetts Institute of Technology.

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Barnard College, Columbia University, has received from an anonymous donor about $1,000,000 to purchase the three blocks of land adjoining the college on the south.

The Indiana legislature has passed bills increasing the tax levy for the higher educational institutions. The income of Indiana University will thereby be increased by about $45,000 annually with a proportionately larger increment from the increase in the value of taxable property.

Harvard University will receive ultimately $10,000 for the establishment of a scholarship and $5,000 for the Semitic Museum by the will of Jacob A. Hecht.

The Carnegie Trust of the Scottish universities has made public an announcement in regard to scholarships, fellowships and grants. The value of the scholarships is £100 and of the fellowships £150, the former being given to afford an opportunity in training for research and the latter to those who are competent to undertake independent research. The number to be awarded is not yet determined, depending on the demand. The grants are to be made only to teachers in Scotland or graduates of Scottish universities resident in Scotland. The recipients of grants may publish their work where they see fit, and instruments of permanent value purchased by means of the grant are to be placed at the disposal of the institution in which the research has been conducted.

The Privy Council has recommended the creation of a University of Liverpool and a University of Manchester, and it is expected that the university colleges of Leeds and Sheffield will be united in a university for Yorkshire.

It was announced to the court of governors of the University of South Wales in Monmouthshire on February 19 that the council had recommended that compulsory Latin for the matriculation should not be required of students in applied science.

The Association of Public School Science Masters sent a delegation to Oxford University on October 14 to urge that the examination for entrance scholarships in science at the universities of Oxford and Cambridge be made more uniform. They also recommended the abolition of compulsory Greek.

The government of Nicaragua will send fifteen students annually to colleges of agriculture in the southern states.

Professor E. F. Nichols, of Dartmouth College, has been elected to a chair of physics in Columbia University. At the same university Mr. Charles A. Strong has been promoted to a professorship of psychology and Dr. Livingston Farrand, adjunct professor of psychology, has been made professor of anthropology.

At Barnard College, Columbia University, Dr. H. M. Richards has been promoted to an adjunct professorship of botany, and Miss Margaret E. Maltby to an adjunct professorship of botany.

Dr. Frederick DeForest Heald, now professor of biology in Parsons College, Iowa, has been elected to the position of adjunct professor of plant physiology and general bacteriology in the University of Nebraska. He will assume office during the summer, and will take part in the work of the university summer session, having charge of the classes in botany.

Miss Margaret F. Washburn, assistant professor of psychology and dean of women in the University of Cincinnati, has been appointed associate professor of philosophy in charge of psychology in Vassar College.

Dr. Eugen Oberhummer, associate professor of geography at Munich, has been called to the chair of geography at Vienna, and Dr. Robert Singer has been made associate professor of geography at the same university.